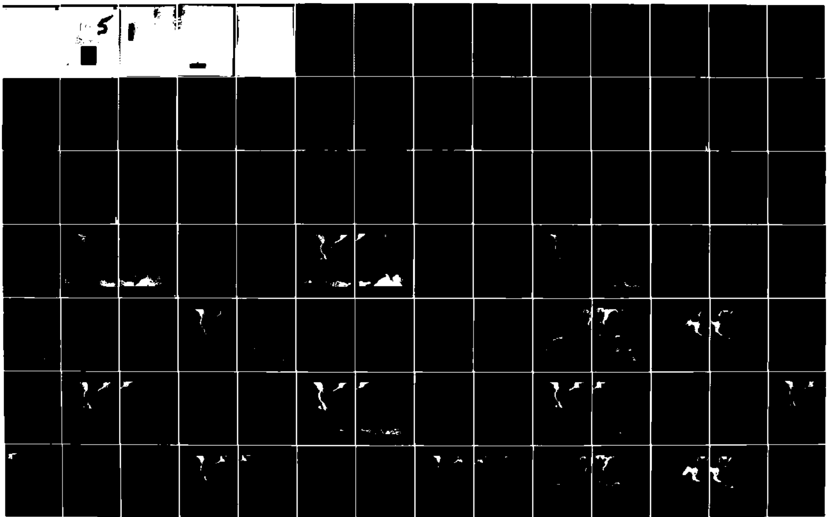
AD-A087 571 NAVAL OCEANOGRAPHIC OFFICE NSTL STATION MS F/G 8/10

ATLAS OF NORTH ATLANTIC-INDIAN OCEAN MONTHLY MEAN TEMPERATURES --ETC

1979 M K ROBINSON, R A BAUER, E H SCHROEDER

UNCLASSIFIED NOO-RP-18 NL



DISCLAIMER NOTICE

March 1980
RP-18

ERRATA

Figure 6.

Red Sea - 15°N 41°E - Color wrong for temperature < 25°

Figure 10.

Baltic south of 58°N - Color wrong for temperature > 5°
South of Sumatra 0°-3°S 99°- 100°E - Color wrong for temperature < 25°

Figure 14.
Bay of Bengal 15°N 84°E - Color missing for depth > 90M

Figure 22.
Northwest corner of Gulf of Mexico - Color missing for temperature > 20°

Figure 26.
Red Sea 19°N 37°E - Color wrong for temperature < 25°

Figure 32.

Gulf of Aqaba - Color wrong for temperature < 20°
Arabian Sea 15°-18°N 60°-64E - Color inside heavy closed contours wrong for temperature < 25°

Figure 36.

In the Gulf of Darien (Atlantic side of the Isthmus of Panama) the contour lines read (from north to south) 25. 24.5, 24. 24, and 24.5.

Figure 42.

Arabian Sea at 15°N 60°E and 12°N 70°E - Color inside heavy closed contours wrong for depth > 60M

Figure 46.

Tongue of the Ocean 23°- 25°N 77°- 78°W - Color wrong for temperature < 25° and color extends into shallow area which should be white

Figure 58.

Baltic - Ice line should be deleted

Figure 64.

In the Gulf of Mexico (west of Florida and northwest of Cuba) the 23.5° contour line should be broken in the same area as the 20.5, 21.5, and 22.5 contour lines. The contour line running southward from the south coast of Grand Bahama Island through the Florida Strait to the north coast of Cuba should intersect the coast just west of the intersection of the 25° contour line with the coast of Cuba. It has a value of 24°.

The 18.5° value north of Yucatan should be 15°. The contour lines east of this value should range from 20° to 15°. They have been left out because of inadequate space.

Figure 72.

Yucatan Peninsula - Color wrong for temperature < 25° (and offset)

Figure 140.

North of Baffin Island - Color wrong for depth < 30M

Figure 144.
Middle of Red Sea - South edge of color for > 30° does not extend to heavy 30° line

Figure 146.

North Sea 55°N 1°E - > should be <

Figure 148.

North of Cuba at 23°N 78°W - There is a north-south 26° line missing which connects the two shallow areas

Figure 158.
Pacific 0-5°S 80°- 96°W - Tongue shaped area extending from Ecuador coast to and beyond Galapagos Islands is wrong color for temperature 20°

Figure 212.

Annual cycle figure labeled 22°N 37°W (Atlantic Ocean) is correct for that location, but curves for 22°N 37°E (Red Sea) should have been printed here

ATLAS OF NORTH ATLANTIC—INDIAN OCEAN AND MEAN SALINITIES OF TH

MARGARET K. ROBINS
COMPASS SYSTEMS, I
SCRIPPS INSTITUTION OF OCEAN

ROGER A. BAUER
COMPASS SYSTEMS, I

ELIZABETH H. SCHROE
WOODS HOLE OCEANOGRAPHIC

1979

DEPARTMENT OF THE NAVY OCEANOGRAPHIC OFFICE

NAVAL OCEANOGRAPHIC OFF
NSTL STATION, BAY ST. LOUIS, MS

1

NOO RP-18

(12)

)IAN OCEAN MONTHLY MEAN TEMPERATURES
IITIES OF THE SURFACE LAYER

RGARET K. ROBINSON
MPASS SYSTEMS, INC.
UTION OF OCEANOGRAPHY (ret.)

ROGER A. BAUER
MPASS SYSTEMS, INC.

ABETH H. SCHROEDER
OCEANOGRAPHIC INSTITUTION

1979

VAL OCEANOGRAPHIC OFFICE
ATION, BAY ST. LOUIS, MS 39522

2

FOREWORD

The temperature charts in this North Atlantic-Indian Ocean atlas are based primarily on bathythermograph data collected from 1941 to 1970, but also on means extracted from published charts and unpublished tabulations. They result from a thorough statistical analysis and reanalysis of the data, supplemented, where necessary, by painstaking subjective analysis.

This atlas will be useful to oceanographers, meteorologists, and marine biologists who undertake studies in the North Atlantic and Indian Oceans requiring knowledge of water temperatures in the upper 492 ft. (150 m). In addition, underwater acousticians may find these data useful in conducting near-surface sound propagation studies.

W. C. PALMER
Captain, USN
Commander

ACKNOWLEDGMENTS

This atlas is a monument to the inventor of the mechanical bathythermograph (BT), Dr. Athelstan F. Spilhaus, and to the thousands of men who used the instrument under all weather conditions, for the BT was the first temperature measurement device that could be used with a ship underway. After 30 years the mechanical BT has given way to the more sophisticated expendable bathythermograph, just as the standard oceanographic instruments, the Nansen bottle and reversing thermometer, are being replaced by the profiling Salinity-Temperature-Depth instruments. There is much to be praised about the mechanical BT. It was the first instrument to give us analogue traces of temperature-depth profiles, whose multifarious shapes had not been imagined from the traditional hydrocast data.

Because of the relative ease with which a BT observation could be taken and the low cost (approximately $500 per instrument, 25¢ per glass slide, $2.00 per observation to photograph the slide against its grid), the United States was able to accumulate during a period of 30 years approximately 1.2 million BT observations. These made it possible for the first time to describe the annual changes of temperature in the upper layer of the ocean and provided our first insight into the surface layer temperature variability over periods of days, months, and years.

The BT observations used in this atlas describe the ocean as it existed between 1941 and 1970. It will be many years before a similar accumulation of temperature data can provide a second estimate of temperature variability and annual change in the upper 150 meters of the world's oceans.

We thank the many departments of the U.S. Navy, whose foresight made the collection, processing, archiving, and subsequent digitization of BT data possible. We hope that the production of this atlas and its companion volume, the Atlas of North Pacific Ocean Monthly Mean Temperatures and Mean Salinities of the Surface Layer, will have made the efforts of all persons involved in the collecting and processing of mechanical BT data worthwhile.

We acknowledge with thanks the 1942 work of Dr. Eugene LaFond and Frederick Fuglister in developing procedures for preserving the enlarged image of the temperature-depth trace from the BT glass slide and corresponding instrument grid. This work was done at the University of California and Woods Hole Oceanographic Institution.

Dr. Taivo Laevastu first recognized the potential value of our surface layer BT temperature analysis to Fleet Numerical Weather Central's weather and ocean prediction models. He introduced our work to CAPT Paul M. Wolff, USN, who actively supported our work by making funds and valuable computer resources available. Without access to the FNWC computer complex, our hemispheric analysis programs could not have been realized. We greatly appreciate the support given by these men.

Thanks are due to the late Dr.
while on a tour of duty at the
Feenan Jennings, Drs. Arthur
while at the Office of Naval
Hamilton, USN, at the Nav
Research Facility, encouraged our

We wish to express our apprec
J.L. Chamberlain of the Nat
Atlantic Environmental Gr
reanalysis of the tropical Atlan
Numerical Weather Central for

We thank John Cochrane
Agricultural and Mechanical Uni
the Gulf of Mexico and Caribbea
University of Hawaii for sharing
national Indian Ocean Expedition
treatment of the upper 150 meter
ments Dr. Wyrtki's excellent de
data.

We wish to thank the authors G
and 1964), and W. Lenz (1971) an
Hydrographische Zeitschrift for
temperature contours in the Nort
published atlases.

We thank the editors of the
Conseil International pour l'Explora
tenlund Slot for permission to repro
in the Irish Sea from the atlas of
waters prepared by G. Dietrich in 19

We wish particularly to thank the
Hole Oceanographic Institution for
puting temperature means: Ethel B.
Phyllis T. Bailey. Many thanks are
Frederick Fuglister, William
Worthington, and Nick Fofonoff for
tinuing support.

We thank those Scripps Institutio
members who prepared the data for t
results: Marguerette Schultz, Vio
Kloehr.

At Compass Systems, Inc., we note
Haines, cartographer, who scribed th
vised the entire color separation and
Ronald McLeod, Sally Roha, and W
quality of their work is greatly appr
Snyder and Willy Billings for their sp
tive reanalysis tasks and are indebted
editorial assistance in preparing the

Dr. C. Fremont Sprague began t
analysis programs in 1960. These pro

1

Thanks are due to the late Dr. John Lyman for his support hile on a tour of duty at the National Science Foundation. eenan Jennings, Drs. Arthur Maxwell and Hugh McLellan, hile at the Office of Naval Research, and CAPT G.D. amilton, USN, at the Naval Environmental Prediction esearch Facility, encouraged our efforts.

We wish to express our appreciation to Drs. M. Ingham and I. Chamberlain of the National Marine Fisheries Service- tlantic Environmental Group, whose grant made possible the analysis of the tropical Atlantic, and to Paul Stevens at Fleet umerical Weather Central for providing Atlantic XBT data.

We thank John Cochrane for lending us the Texas gricultural and Mechanical University BT data collection for e Gulf of Mexico and Caribbean and Dr. Klaus Wyrtki of the niversity of Hawaii for sharing his corrected tape of the International Indian Ocean Expedition's hydrocast and BT data. Our eatment of the upper 150 meters of the Indian Ocean supplements Dr. Wyrtki's excellent detailed treatment of the deep ta.

We wish to thank the authors G. Tomczak, E. Goedecke (1962 nd 1964), and W. Lenz (1971) and the editors of the Deutsche ydrographische Zeitschrift for allowing us to reproduce mperature contours in the North and Baltic Seas from their blished atlases.

We thank the editors of the Service Hydrographique of the onseil International pour l'Exploration de la Mer, Charlottenlund Slot for permission to reproduce temperature contours the Irish Sea from the atlas of the North Sea and adjacent aters prepared by G. Dietrich in 1962.

We wish particularly to thank the following persons at Woods ole Oceanographic Institution for processing BT data and computing temperature means: Ethel B. Allen, Winifred Frank, and illis T. Bailey. Many thanks are also given Henry Stommel, ederick Fuglister, William Metcalf, L. Valentine orthington, and Nick Fofonoff for encouragement and continuing support.

We thank those Scripps Institution of Oceanography staff embers who prepared the data for the computer and checked sults: Marguerette Schultz, Viola Fleming, and Bettina oehr.

At Compass Systems, Inc., we note with special thanks Susan ines, cartographer, who scribed the atlas charts and supervised the entire color separation and labeling process done by nald McLeod, Sally Roha, and William Krausmann. The ality of their work is greatly appreciated. We thank Dories yler and Willy Billings for their special assistance in subjective reanalysis tasks and are indebted to Donna Bauer for her torial assistance in preparing the final text.

Dr. C. Fremont Sprague began the development of the alysis programs in 1960. These programs were converted to the Fleet Numerical Weather Central computers by Marilyn McLennan and used by James N. Perdue to produce early results. Terry DeBerry assisted in preparing the data distribution and time series charts.

We also wish to express our appreciation to Kenneth Pyle, Chief Cartographer, County of San Diego, for his guidance and assistance and to his staff for their part in performing the photo and chemical etching processes on the master black art and color separation sheets. We are indebted to the staff at Teledyne Geotronics who made their Kongsberg plotter available to scribe the data distribution charts when other equipment failed to produce satisfactory results.

Funds for this project were provided by the following U.S. agencies:

BT Processing
- U.S. Navy Bureau of Ships 1942-1946
- Office of Naval Research 1946-1972
- U.S. Navy Hydrographic Office 1956-1960
- U.S. Naval Oceanographic Office 1960-1970
- National Science Foundation - University National Oceanographic Laboratory System 1972-1975

Temperature Analysis
- Office of Naval Research 1946-1972
- National Science Foundation 1960-1961
- Fleet Numerical Weather Central 1965-1975
- Naval Environmental Prediction Research Facility 1975-1977

Publication
- National Science Foundation 1976-1977
- National Oceanic and Atmospheric Administration 1976-1977
- U.S. Naval Oceanographic Office 1978
- Defense Mapping Agency Hydrographic Center 1978

We thank the Oceanographer of the Navy for approving the publication of this atlas and we greatly appreciate the assistance received from Government staff members.

Cuthbert Love, oceanographer, made a final proofing of the artwork. Dennis West, DMA, handled the figures.

Finally, we are grateful for the encouragement and assistance given us by Dr. Boyd E. Olson, Scientific and Technical Director of the Naval Oceanographic Office and Captains James E. Ayres, John R. McDonnell and Wallace C. Palmer, Commanders of the Naval Oceanographic Office. We thank Mr. Charles Hicks and the many employees of the Defense Mapping Agency Hydrographic Center who photographed, stripped, printed and bound this publication.

Margaret K. Robinson
Roger A. Bauer
Elizabeth H. Schroeder

CONTENTS

* FIGURES

***There are no page numbers other than figure numbers.**

1

FIGURES (con.)

FIGURES (con.)

FIGURES (con.)

FIGURES (con.)

2

FIGURES (con.)

FIGURES (con.)

INTRODUCTION

This North Atlantic-Indian Ocean Atlas contains monthly mean sea temperatures at the surface and five subsurface levels at 100-ft (30-m) intervals to 492 ft (150 m). The choice of the 100-ft depth interval continued the analysis standard set by earlier studies of subsurface temperature distribution in the Pacific Ocean based on BT data. These depths are clearly marked on BT grids making depth interpolation unnecessary and minimizing reading errors. The selected five equal 100-ft intervals are the minimum required to describe the basic subsurface temperature structure. A large proportion of the BT data was processed in Fahrenheit degrees; however, to conform with general oceanographic usage publication is in degrees Celsius. A Fahrenheit-Celsius conversion table appears on each temperature chart for the convenience of the user.

Mean salinities are also presented at the six levels. The salinity values are means of the National Oceanographic Data Center (NODC) 1969 collection of hydrocast station data. The means are not true annual means because very little winter data have been collected, particularly in the northern seas, and the means are therefore designated "all-data" means.

Included are charts derived from monthly means consisting of monthly topographies of the top of the thermocline, monthly temperature differences between the surface and 400 ft (120 m), annual means and ranges for each of the six levels, and annual cycle curves for selected locations demonstrating surface and subsurface seasonal temperature variations. A foot-meter conversion table appears on each thermocline chart and a temperature difference conversion table on the charts of temperature difference between the surface and 400 ft (120 m) and charts of annual temperature range.

A matching data distribution chart is provided for each monthly and annual temperature chart at all levels and for the surface salinity charts only, since the salinity data distribution for all levels to 150 meters is essentially the same.

The Atlantic section of the charts extends from 5°S to 73°N and from 100°W to 75°E, but contours in the northwest stop at Hudson Strait and in the northeast at 45°E in the Barents Sea and do not extend south into the White Sea. The Indian Ocean insert covers the area 5°S to 30°N, 32°E to 103°E.

The monthly temperatures and all-data salinities in this atlas are a portion of the Bauer-Robinson Numerical Atlas on magnetic tape. The charts were traced from computer-generated contour charts from the Numerical Atlas. Data in the Numerical Atlas contain temperature and salinity values at the surface, subsurface 100-ft levels, and at all NODC hydrocast depth levels from 150 to 5,000 meters. Additionally, the tape contains means at Fleet Numerical Weather Central (FNWC) analysis levels: 600, 800, 1000 and 1200 ft.

LITERATURE REVIEW

Modern oceanography, the analysis of the physics of the sea, was not possible until theory and instruments capable of accurately sampling water at depth were developed at the end of the 19th
century. Von Arx (1962) reviewed
fluenced thought in the marine
the Mediterranean. Deacon (1971)
Sea 1650-1900" with particular
tidal theory and the origin of the
Prestwich (1875) summarized the
observations of over sixty expedi
tions between 1749-1868 and dis
temperature distribution in the de
extensive searches of original pub
From these sources the develo
oceanography and the navigationa
which made it possible are summa

Western man's knowledge of the
Phoenicians and Greeks in the Medi
Recent evidence from stone inscrip
pottery shards discovered in both
described by Fell (1976) indicates tha
Egyptian traders may have reache
B.C. and 500 A.D. With the fall of Ro
the skills and knowledge of the
knowledge of their early voyages an
Viking voyages, were lost to Europe
tific knowledge of the Greeks and
bian scholars and rediscovered by
the Crusades in the 11th century, h
Moors into Spain after their 8th centu

Navigational instruments used in
ly forms of the magnetic compas
magnetic compass was again in us
common use by 1200 A.D. Althoug
not understood, it was recognized
pensate for it. The astrolabe, which
vented by the Greeks, was known
was lost until around 1300, but was
With these navigational instrument
ploration began with Bartholomew
and Vasco da Gama, 1497, followe
world expedition of 1519-1522.

In the following 200 years, while
highway for ships of Spain, France
colonize and plunder the new world,
great natural philosophers and math
nicus, Mercator, Kepler, Galileo,
Newton, and Leibnitz, was layin
knowledge and techniques that
standing of the physics of the ocean,
tion, and distribution of temperatu

Hand-in-hand with the increase in
the invention and improvement of
The invention of the sextant in 17
Hadley, Englishman, and Thomas
improved latitude measurements. T
use with little change to the present
longitude was still a serious navi
Queen Anne of England offered a p
invention of an accurate chronomet
was won by John Harrison in 1762.
invention in 1714 of the mercury th
establishment of the Fahrenheit (F

century. Von Arx (1962) reviewed the history of events that influenced thought in the marine sciences, starting in 640 B.C. in the Mediterranean. Deacon (1971) published "Scientists and the Sea 1650-1900" with particular emphasis on the development of tidal theory and the origin of the salt content in the oceans. Prestwich (1875) summarized the oceanographic temperature observations of over sixty expeditions conducted by seven nations between 1749-1868 and discussed the early theories of temperature distribution in the deep seas. These authors made extensive searches of original publications not available to us. From these sources the development of the science of oceanography and the navigational and measuring instruments which made it possible are summarized.

Western man's knowledge of the oceans began with the early Phoenicians and Greeks in the Mediterranean and Aegean Seas. Recent evidence from stone inscriptions, bronze weapons and pottery shards discovered in both North and South America, described by Fell (1976) indicates that Celtic, Basque, Iberian, and Egyptian traders may have reached the Americas between 1500 B.C. and 500 A.D. With the fall of Rome, trade had collapsed and the skills and knowledge of the early mariners, as well as knowledge of their early voyages and the later (800-1400 A.D.) Viking voyages, were lost to Europeans. Fortunately, the scientific knowledge of the Greeks and Romans, preserved by Arabian scholars and rediscovered by northern Europeans during the Crusades in the 11th century, had been reintroduced by the Moors into Spain after their 8th century conquest of that country.

Navigational instruments used in the Roman era were the early forms of the magnetic compass and the astrolabe. The magnetic compass was again in use around 1000 A.D. and in common use by 1200 A.D. Although magnetic declination was not understood, it was recognized and attempts made to compensate for it. The astrolabe, which measured latitude, was invented by the Greeks, was known to the Romans, apparently was lost until around 1300, but was again in general use by 1350. With these navigational instruments the era of great ocean exploration began with Bartholomew Diaz, 1488, Columbus, 1492, and Vasco da Gama, 1497, followed by Magellan's round the world expedition of 1519-1522.

In the following 200 years, while the North Atlantic was the highway for ships of Spain, France, England, and Holland to colonize and plunder the new world, scientific inquiry by many great natural philosophers and mathematicians, such as Copernicus, Mercator, Kepler, Galileo, Descartes, Hooke, Halley, Newton, and Leibnitz, was laying the foundation of the knowledge and techniques that would lead to our understanding of the physics of the ocean, its currents, tides, circulation, and distribution of temperature, salinity, and chemicals.

Hand-in-hand with the increase in scientific knowledge came the invention and improvement of navigational instruments. The invention of the sextant in 1730 independently by John Hadley, Englishman, and Thomas Godfrey, American, greatly improved latitude measurements. The sextant has remained in use with little change to the present. Accurate determination of longitude was still a serious navigational problem. In 1714, Queen Anne of England offered a prize of 20,000 pounds for the invention of an accurate chronometer for use at sea. The prize was won by John Harrison in 1762. Of equal importance was the invention in 1714 of the mercury thermometer, followed by the establishment of the Fahrenheit (F) temperature scale in 1724 and the Centigrade (Celsius [C]) scale in 1742.

Soon thereafter, scientific expeditions were organized to measure ocean temperature, not only at the surface but also at great depths. Between 1749 and 1868 there were over sixty expeditions undertaken by ships of Great Britain, France, Russia, the Netherlands, Austria, Denmark, and the United States. These expeditions gathered surface and subsurface temperatures in the Atlantic, Pacific, and Indian Oceans from the Arctic to the Antarctic.

According to Prestwich the bulk of the subsurface measurements that he summarized from these early expeditions was taken by self-registering maximum-minimum thermometers invented by James Six in 1782 or by modifications of his instrument by both French and British artisans. In 1842, the Frenchman Aime devised a crude form of reversing thermometer which he used in the Mediterranean. In 1857, the British firm of Negretti and Zambra experimented with a protected thermometer, but not until 1874, after the beginning of the *Challenger* Expedition, were protected and unprotected thermometers perfected by that firm.

The early discoveries in the subsurface waters were that temperature decreased rapidly from the surface, then more gradually at greater depths; that subsurface water beneath the equator was colder than that to the north and south. As early as 1780 the Frenchman Saussure discovered that the deep water in the western Mediterranean had a uniform temperature of approximately 55.7°F (13.2°C), confirmed by Berard in 1831-32 and Aime in 1840-44. In 1826-29, the Frenchman D'Urville concluded from deep temperature measurements made aboard the *Astrolabe* that in the open ocean temperature at and below 3200 feet (975 m) was constant between 39-41°F (3.9-5°C). In 1839, England's Sir James Ross was dispatched on the joint expedition of the *Discovery* and *Research* to investigate the Antarctic Ocean. He concluded, as did D'Urville, that there was a persistence of uniform temperature of 39.5°F (4.1°C) below certain depths in the great oceans. Similarly, the American Wilkes on the U.S. exploring expeditions of the *Vincennes* and *Peacock* 1839-42, came to the same conclusion.

Even Sir Wyville Thomson, until the voyage of the *Lightning* in 1868, had accepted the idea of the constant 4°C temperature water in the deep ocean because, as quoted by Deacon (p. 308), "the fallacy had been accepted and taught by nearly all the leading authorities in Physical Geography." These men had ignored or been unaware of the findings of the Englishman Marcett in 1819 and the Frenchmen, Erman in 1828 and Despretz in 1837, that the freezing point and point of maximum density of sea water varied with the salinity of the water and that freezing points as low as 28.4°F (-2°C) could occur. Errors in judgment of the early explorers were primarily due to the improper application of pressure corrections to their observations.

The Russian Lenz, however, as early as 1823-26, had proved that in the open ocean temperatures at great depths were little above 0°C (32°F). The Frenchman, Du Petit-Thouars, in 1836-39, fully confirmed Lenz's observation that temperatures from 35-37°F (1.7-2.8°C) existed at great depths in both the great oceans.

As early as 1812 and again in 1831, von Humboldt contended that the existence of cold layers in low latitudes proves the existence of undercurrents flowing from the poles to the equator.

Without these submarine currents, he claimed, the tropical seas at depth could only have a temperature equal to the "local maximum of cold of the falling particles of water" from the cooled surface of the tropical sea. In the Mediterranean the absence of cold water at depth was explained by the Frenchman Arago in 1838 by the assumption that the entrance of deep polar currents into the Mediterranean was prevented by the shallow sill at the Straits of Gibralter, resulting in the constant 13.2°C deep temperatures reported by Berard and Aime. Lenz, both in 1831 and 1845, reviewing data furnished by himself and others, noticed the existence of a belt of water at or near the equator cooler than that at a short distance to the north and south, and that the maximum salinity does not occur at the equator but some degrees north and south from it, at 23°N and 17°S in the Atlantic.

From the data he had collected, edited, and corrected, Prestwich (1875) was the first to prepare and publish longitudinal temperature sections from the surface to great depths (two sections in the Atlantic and two in the Pacific from the Arctic to the Antarctic, one in the Pacific east of Australia from 25°S to 68°S, and one in the Indian Ocean from 20°N to 40°S).

Meanwhile, LT Maury, USN, at the World Meteorological Conference, Brussels, Belgium, in 1853, proposed that sea surface temperature and meteorological data be collected and archived on a worldwide basis by ships of all member nations. In 1855 he published "The Physical Geography of the Sea," which contained the first sea surface temperature charts of the North Atlantic. The collection of sea surface temperature data begun by Maury is now being maintained and continually updated by the Environmental Data Service, National Climatic Center, Asheville, North Carolina.

The celebrated *Challenger* Expedition of 1872-76, whose collections of sea life, ocean bottom depths, and sediments contributed so greatly to the knowledge of these subjects, also added many details but did not greatly change the concepts of the physical oceanography of the seas as described by Prestwich. The reason for this was that the temperature measurements were made from Miller-Casella thermometers, each requiring its own pressure correction determination. Unfortunately, an error was made in computing the pressure corrections and the corrections applied were too large. The Siemens electrical resistance thermometers that were aboard had been sent home before the *Challenger* went beyond the Antarctic Convergence because of the difficulty in using them at sea. When the subsurface temperature inversion was encountered, instruments capable of measuring the inversion were not available. Upon reaching Hong Kong in 1874, Negretti-Zambra's reversing thermometers were placed on board. After some initial difficulties, they worked well, but the results were higher than those obtained by the improperly corrected Miller-Casella thermometers and were therefore questioned and only occasionally used. The *Challenger* returned to the Atlantic through the Straits of Magellan and did not encounter again deep temperature inversions. In spite of the difficulties with the thermometers, the *Challenger* did discover that temperatures in the deep South Atlantic were higher on the east side than on the west side, from which Tizard (1876) deduced the existence of the Mid-Atlantic Ridge and the Walvis Ridge although Wyville Thomson did not accept Tizard's ideas. The Puerto Rico trench and Mariana trench were discovered but the bottoms were not reached when the thermometers burst, as greater depths were encountered than had been anticipated. The chemist, Buchanan, who discovered the error in the pressure corrections, published in 1884 a report on the specific gravity of the *Challenger* water samples.

Buchan (1895) summarized corrected *Challenger* and other pre-1895 deep data in 12 horizontal isothermal charts between the surface and 1500 fathoms, and Murray (1898) discussed the annual range of temperature in surface water of the oceans and its relation to other oceanographic phenomena, based on *Challenger* and other observations.

In 1877, Alexander Agassiz, aboard the U.S. Coast Survey ship *Blake*, surveyed in the Caribbean and Gulf of Mexico. Tizard and Murray (1882) and Tizard (1883) reexamined the Faeroe Channel in the summers of 1880 and 1882, discovering and naming the shallow Wyville Thomson Ridge, which separates the Arctic Basin from the North Atlantic Basin and which has important consequences on subsurface temperature and salinity distributions. In 1885, Alberto I, Prince of Monaco, began systematic oceanographic observations in the Mediterranean and North Atlantic aboard his yachts, *Hirondelle* and *Princess Alice*. In 1890 Pillsbury published his observations of the velocity of the Gulf Stream made from the *Blake* at anchor stations in the Florida Straits and in the waters of Cape Hatteras and in the passages of the Windward Islands.

Publications of the Norwegians, Bjerknes (1898) and Bjerknes and Sandstrom (1910-11), marked the beginning of the modern physics of the oceans. Bjerknes provided a theoretical basis for determining the field of motion in the sea from measurements of the vertical and horizontal distributions of pressure. Knudsen had already published hydrographic tables for the conversion of chlorinity to salinity and to sigma-T in 1901. In 1915 Hesselberg and Sverdrup published tables for the computation of pressure and mass distribution.

When Fridtjof Nansen developed the reversing water bottle in 1914 for use with the protected and unprotected mercury thermometers, which had come into general use and were being produced by C. Richter or Smith and Vossberg in Berlin, theory, instruments, and computational methods of modern oceanography had become established.

Meanwhile, the International Council for the Exploration of the Sea (ICES), founded in 1902, began in 1908 to publish hydrocast data collected by ships of member nations in the North Atlantic Ocean and North and Baltic Seas. Publication of hydrocast data by ICES has continued to date except during the years 1915-26. Hydrocast data from 1930-59 from ICES publications were used in this atlas.

Helland-Hansen and Nansen (1926) published their observations of temperature and salinity taken in the eastern North Atlantic by the *Armauer Hansen* in 1913, 1914, and 1922. Also used in the preparation of charts of temperature, salinity, and density were summer observations previously collected using modern instruments, on the following cruises: *Michael Sars*, 1910; *Fridtjof*, 1910; *Fram*, 1910; *Thor*, 1905-6, 1910, 1911; *Dana*, 1922; *Planet*, 1906; *Mowe*, 1911; *Deutschland*, 1911; *Margrethe*, 1913; and *Princess Alice*, 1902-3.

The International Ice Patrol was established in 1914 after the *Titanic* disaster. Smith (1926) of the U.S. Coast Guard showed

ed than had been anticipated. The
overed the error in the pressure
a report on the specific gravity of

corrected *Challenger* and other
zontal isothermal charts between
and Murray (1898) discussed the
n surface water of the oceans and
phic phenomena, based on *Chal-*

aboard the U.S. Coast Survey ship
an and Gulf of Mexico. Tizard and
) reexamined the Faeroe Channel
882, discovering and naming the
dge, which separates the Arctic
Basin and which has important
mperature and salinity distribu-
ice of Monaco, began systematic
the Mediterranean and North
Hirondelle and *Princess Alice*. In
bservations of the velocity of the
Blake at anchor stations in the
ters of Cape Hatteras and in the
ands.

ans, Bjerknes (1898) and Bjerknes
ked the beginning of the modern
s provided a theoretical basis for
in the sea from measurements of
stributions of pressure. Knudsen
graphic tables for the conversion
o sigma-T in 1901. In 1915 Hes-
ed tables for the computation of
n.

loped the reversing water bottle
d and unprotected mercury ther-
nto general use and were being
h and Vossberg in Berlin, theory,
ational methods of modern
ablished.

al Council for the Exploration of
1902, began in 1908 to publish
ships of member nations in the
th and Baltic Seas. Publication of
ntinued to date except during the
from 1930-59 from ICES publica-

n (1926) published their observa-
nity taken in the eastern North
sen in 1913, 1914, and 1922. Also
rts of temperature, salinity, and
ations previously collected using
following cruises: *Michael Sars*,
0; *Thor*, 1905-6, 1910, 1911; *Dana*,
1; *Deutschland*, 1911; *Margrethe*,
-3.

was established in 1914 after the
of the U.S. Coast Guard showed

that Bjerknes' principles could be applied to circulation in the Labrador Sea and Baffin Bay. Since that time the U.S. Coast Guard has collected both hydrocast and BT data in these areas.

In the period between 1920 and 1938 many important oceanographic expeditions took place in the Atlantic and adjacent seas. These included German expeditions aboard the *Meteor* and *Altair*, Danish expeditions on the *Dana* and *Godthaab*, U.S. expeditions on the *Atlantis* and *Mabel Taylor* and a Norwegian expedition aboard the *Armauer Hansen*. These expeditions used the modern reversing thermometer and Nansen bottle.

Schott (1935) published his "Geographie des Indischen und Stillen Ozeans." He made use of oceanographic data collected by the Dutch *Snellius* Expeditions, 1929, 1930, and 1931, which were not published until much later (Van Riel, Groen and Weenink, 1957). In 1935 Lumby published an atlas of surface temperature and salinity distribution of the English Channel based on data from 1909-1927. The year 1936 saw the publication of two of the *Meteor* Expedition's atlases, Wust and Defant on the stratification and circulation of the Atlantic Ocean, and Bohnecke on the temperature, salinity, and density at the surface of the Atlantic. In the same year, Iselin published an account of the circulation of the western North Atlantic based mainly on evidence of dynamic sections. In 1937 Parr reported on the time variations of temperature, salinity, and flow velocity in the Straits of Florida. Spilhaus reported his important instrument design, the mechanical BT, in 1938.

In 1940 Iselin discussed the variation in the transport of the Gulf Stream on the basis of 15 dynamic sections made between Montauk Point and Bermuda. Sverdrup, Johnson, and Fleming (1942) published "The Oceans: Their Physics, Chemistry and General Biology." In the same year Schott published his "Geographie des Atlantischen Ozeans." Both Sverdrup and Schott based their discussions on the modern oceanographic data collected since 1900. Schott's book contained a wide selection of topics, ranging from early voyages of exploration to meteorology and commerce in addition to discussion and charts of distributions of temperature and salinity. Sverdrup's chapter on the water masses and currents of the oceans is the first detailed worldwide summary and description of these subjects that provided the basic framework for post-1945 theoretical studies and oceanographic exploration. Neither was able to publish details of the annual variation of temperature in the upper 150 meters of the ocean. It took more than 30 additional years for a sufficient collection of BT and hydrocast data to make this possible.

Since 1946 a number of summaries of temperature data in the North Atlantic and Indian Oceans have been published. Fuglister (1947) published charts of monthly sea surface temperatures of the western North Atlantic based on BT and hydrocast data to 1946. Krauss (1958) published monthly charts of sea surface temperature and salinity in the North Atlantic between 50°N and 80°N, as well as tabulations of hydrocast data collected between 1870 and 1953. His charts show considerable variability in salinity as well as temperature from month to month. The position of the 35‰ isoline shifts widely from the mean position shown in this atlas. Although individual observations occasionally show intrusions of 35‰ water nearer to the coast of Greenland, the all-data means locate the western boundary of this isoline north of 55°N at approximately 33°W.

In 1960, Fuglister published an "Atlantic Ocean Atlas of Temperature and Salinity Profiles and Data from the International Geophysical Year of 1957 1958." The BT traces collected on this expedition are reproduced therein and are part of the data used in this atlas. Dietrich (1962) published "Mean Monthly Temperature and Salinity of the Surface Layer of the North Sea and Adjacent Waters from 1905 to 1951." Tomczak and Goedecke, in 1962 and 1964, published vertical and horizontal charts of temperature distribution in the North Sea based on sea surface and hydrocast data from 1902-1954.

In 1963 Schroeder published "North Atlantic Temperatures at a Depth of 200 Meters" based on a subset of all-data means computed from the 1962 running monthly means of hydrocast and BT data on file at the Woods Hole Oceanographic Institution (WHOI). In 1965 Schroeder published "Average Monthly Temperatures in the North Atlantic Ocean." This paper contained monthly profiles along eight meridians, surface to 300 meters from 20°N to the coasts of New England, Canada, Greenland, and Iceland based on WHOI's combination of hydrocast and BT temperature data means. In 1966 Schroeder published "Average Surface Temperatures of the Western North Atlantic" where she noted that her values were 1-2°C higher than those in the same area published by Fuglister (1947). In comparison with Bohnecke (1936) and the U.S. Navy H.O. 225 (1944), there was a temperature difference of +2°C in summer months and -3°C south of Cape Hatteras in winter. Also in 1963 Cochrane published results of Texas A&M College's expedition to study the equatorial undercurrent and related currents off Brazil.

Wust (1964) published "Stratification and Circulation in the Antillean-Caribbean Basins," using analysis methods he had developed in his 1936 work on the *Meteor* data. Smed (1964a) published anomalies of sea surface temperature in the area 50°N to 67°N, 0° to 50°W from 1876 to 1961, showing some anomalies larger than ±1°C. In particular, the period 1930-1960 had on the average higher temperatures than the period 1900-1930. In the same publication, Smed (1964b) presented salinity anomalies for the Celtic Sea, 47°N to 52°N, 5°W to 10°W, 1903-1958. These anomalies range from +0.19 to -0.13‰. Mann, Grant and Foote (1965) of the Bedford Institute of Oceanography published an atlas of oceanographic sections in the northwest Atlantic Ocean based on data taken in February 1962 and July 1964.

Buljan and Zore-Armanda (1966) published the 1952-1964 collection of hydrographic data in the Adriatic. These data were combined with BT data in the preparation of this atlas. In 1967 the U.S. Naval Oceanographic Office published their most recent atlas of the North Atlantic sea surface temperature based on data from 1854 through 1958 in Pub. 700. Sea surface temperature atlases based on data extending back into the 19th century, including the U.S. Navy Hydrographic Office atlas of sea surface temperatures (1944), and those of the Koninklijk Nederlandsch Meteorologisch Instituut—Red Sea and Gulf of Aden (1949), Indian Ocean (1952) and Mediterranean Sea (1957), and LaViolette and Mason's monthly charts of sea surface temperatures of the Indian Ocean (1967), have a negative bias of approximately 0.5° - 1°C relative to the sea surface temperature derived primarily from BT data taken between 1942 and 1966. To remove this bias, isotherm patterns, rather than absolute temperatures, were followed when values from these atlases were used to fill our fields in no-data areas.

Several publications between 1967-1969 were extremely use-

ful. These included Nowlin and McLella
Mexico in winter, Mazeika's atlas of the
on sea surface data 1854-1963, Cochr
surface salinity off northeastern Sout
1964, Walford and Wicklund's "Mo
Structure from the Forida Keys to Ca
BT data collected 1941-1964 in the W
atlas of oceanographic sections, 196
Davis and Denmark Straits, Labrador
atlas of the Tyrrhenian Sea, a joint publi
Nazionale delle Ricerche, Rome, and the
Navale, Naples, by Aliverti, Picotti, T
and Moretti was based on both hydro
were not in the WHOI files. Their temp
detailed, but are in good general agreem

In 1969, Dietrich published his "Atlas
of the Northern North Atlantic Ocean
1958." The IGY years 1957-1958 prod
peratures in the surface layer of both
Oceans. Smed's (1964) anomalies in
area show annual positive anomalies for
charts indicate that the largest positive a
the winter and that summer temperatures w
A similar situation occurred in the nort
Dietrich's surface winter charts were warme
ing in Krauss (1958). In summer differen
0°C isotherm extends south to 68°N alon
land in Dietrich's summer chart, but only
the Krauss charts, while there is less differ
of the 5°C and 10°C isolines in the summ
atlases. The 35‰ isoline approaches clos
Dietrich's charts in both winter and su
differences in location from Krauss' ch
means in this atlas appear to be a comp
charts of Dietrich and Krauss.

In 1970 results of 1961 expeditions of the W
and *Chain* in the Mediterranean, Adriatic an
published by Miller, Tchernia, Charnock an
cast and BT data collected on these expe
porated in this atlas. Duing (1970) publish
discussion, "The Monsoon Regime of the Cur
Ocean." His paper was based on Wyrtki's hy
the International Indian Ocean Expedition da
this atlas. Also in 1970 Roufogalis publishe
conditions in the Aegean Sea. This atlas
winter temperature charts at the surface a
depths, and salinity charts at the surface an

In 1971 Wyrtki's Indian Ocean Expe
published. His atlas contains detailed ch
temperature, salinity, oxygen, phosphate
silicate distributions, water mass analyses,
surface temperatures for the year 1963. I
prehensive oceanographic atlas of the India
combined BT and hydrocast data tapes were
Indian Ocean monthly temperature charts a
charts in this atlas.

Lenz (1971) published his detailed atlas of
surface and nine subsurface levels in the Balti
1902 to 1956. Colton and Stoddard (1972) p
Monthly Sea-Water Temperatures Nova Sco
1940-1959." This detailed atlas includes mont
depths between the surface and 100 meters

se included Nowlin and McLellan's study of the Gulf of in winter, Mazeika's atlas of the tropical Atlantic based urface data 1854-1963, Cochrane's report of low sea-salinity off northeastern South America in summer Walford and Wicklund's "Monthly Sea Temperature e from the Forida Keys to Cape Cod," derived from collected 1941-1964 in the WHOI file, and Grant's oceanographic sections, 1965-1967, covering the nd Denmark Straits, Labrador and Irminger Seas. The the Tyrrhenian Sea, a joint publication of the Consiglio le delle Ricerche, Rome, and the Instituto Universitario Naples, by Aliverti, Picotti, Trotti, De Maio, Lauretta retti was based on both hydrocast and BT data that t in the WHOI files. Their temperature fields are more , but are in good general agreement with this atlas.

69, Dietrich published his "Atlas of the Hydrography Northern North Atlantic Ocean (Winter and Summer The IGY years 1957-1958 produced anomalous tem-s in the surface layer of both Atlantic and Pacific Smed's (1964) anomalies in the Iceland-Greenland w annual positive anomalies for 1957-1958. Dietrich's ndicate that the largest positive anomalies occurred in er and that summer temperatures were close to normal. ar situation occurred in the northeast Pacific Ocean. 's surface winter charts were warmer than those appear-rauss (1958). In summer differences were variable. The herm extends south to 68°N along the coast of Green-Dietrich's summer chart, but only to 74°N in August in uss charts, while there is less difference in the locations °C and 10°C isolines in the summer charts of the two The 35‰ isoline approaches closer to Spitzbergen in 's charts in both winter and summer with random ces in location from Krauss' charts elsewhere. The n this atlas appear to be a compromise between the l Dietrich and Krauss.

results of 1961 expeditions of the WHOI ships *Atlantis* n in the Mediterranean, Adriatic and Aegean Seas were d by Miller, Tchernia, Charnock and McGill. The hydro-BT data collected on these expeditions were incor-in this atlas. Duing (1970) published a comprehensive n, "The Monsoon Regime of the Currents in the Indian His paper was based on Wyrtki's hydrocast data tape of national Indian Ocean Expedition data that was used in s. Also in 1970 Roufogalis published an atlas of ocean s in the Aegean Sea. This atlas included summer-emperature charts at the surface and five subsurface nd salinity charts at the surface and at 50 meters.

71 Wyrtki's Indian Ocean Expedition atlas was d. His atlas contains detailed charts of the deep ture, salinity, oxygen, phosphate phosphorous, and distributions, water mass analyses, and monthly sea temperatures for the year 1963. It is the most com-ve oceanographic atlas of the Indian Ocean. Wyrtki's d BT and hydrocast data tapes were used to produce the cean monthly temperature charts and all-data salinity n this atlas.

1971) published his detailed atlas of temperature at the and nine subsurface levels in the Baltic Sea on data from 1956. Colton and Stoddard (1972) published "Average Sea-Water Temperatures Nova Scotia to Long Island 59." This detailed atlas includes monthly charts at eight between the surface and 100 meters and eight vertical sections from 64.5°N to 71.5°N. The larger size of these charts gives more definition to the complicated region of the Gulf Stream, slope, and shelf water masses than does this atlas, but there is good agreement between the two atlases because the data bases cover approximately the same period.

In 1973 the International Cooperative Investigations of the Tropical Atlantic (ICITA) oceanographic atlas, covering EQUALANT I and EQUALANT II Expeditions to the tropical Atlantic, was published. Hydrocast and BT data collected on these expeditions were used in our 1974-1975 reanalysis of the tropical Atlantic. Robinson (1973a) published an "Atlas of Monthly Mean Sea Surface and Subsurface Temperature and Depth of the Top of the Thermocline Gulf of Mexico and Caribbean Sea." Contours from that publication are reproduced here with the exception of the area north of 20°N and east of 75°W, which was reanalyzed in 1975. Robinson also published (1973b) an atlas of monthly temperatures in the Mediterranean, Black and Red Seas in °F that is recontoured here in °C. In the same year Robinson (1973c) published an atlas of the Red Sea temperature structure in °C, but at somewhat different depths than those included here. Both of these atlases were published in $8 \times 10\frac{1}{2}$-inch page size. A selection of four seasonal sets of Red Sea temperature charts by Robinson was published by the Centre National pour l'Exploitation des Oceans (CNEXO) in 1974.

In 1974 a revised edition of the U.S. Navy "Marine Climatic Atlas of the World, volume I, North Atlantic Ocean" was published, which provided the ice lines used in this atlas.

The Robinson (1976) atlas of North Pacific monthly mean temperatures and mean salinities of the surface layer is a companion volume to this North Atlantic Indian Ocean atlas, in scale, size, and analysis methods. Temperature and salinity contours in the tropical Pacific, east of 100°W, and in the Gulf of Thailand west of 103°E, are included in both atlases.

CHARTS

The horizontal charts were traced from computer-generated plots made directly from the 1°-quadrangle temperature means in hundredths of a degree Celsius and salinity means in hundredths of a part per thousand. The computer plots were hand smoothed to remove contour irregularities produced by the two-dimensional linear interpolation contouring program. The intention was to keep the final contours within 0.1°C of the numerical values. This degree of smoothing did not permit removal of all noise in the fields. Although the computer-generated contours end wherever there are fewer than four data points, the contours were extended to the land boundaries using computer data listings as a guide.

On all horizontal charts tight gradients are indications of features encountered on current and water mass boundaries, along coasts, and at the intersections of the horizontal chart levels with the thermocline. Space and time averaging diminish the real shear that occurs within the tight gradient areas.

The values for annual means, ranges, temperature differences, and depths of the top of the thermocline are computed from the final sets of 12 monthly means.

The top of the thermocline is defined as the depth at which the temperature is 2°F (1.1°C) less than the surface temperature. This definition differs from that of "mixed layer depth." The

surface temperature minus 2°F depth has been selected for deriving the top of the thermocline from smooth average temperatures, because it is greater than the small positive and negative gradients near the surface that are present in both the raw data and the analyzed values, and it is large enough to reach the large gradients found in the seasonal or permanent thermoclines. It does not distinguish between the two.

In summer in northern latitudes, where the seasonal thermocline is well developed and the break in the slope of a temperature-vs.-depth graph is very sharp, the bottom of the mixed (isothermal) layer and the derived minus 2°F depth agree very well. In spring in northern latitudes, however, when the top of the thermocline is ill-defined as the seasonal thermocline is developing and small transient negative gradients may occur throughout the water column, the surface temperature minus 2°F (1.1°C) can be expected to vary, as it may be at the top of the permanent thermocline or a new seasonal thermocline. The computation, however, does provide an indication of the amount of heat that has penetrated to the given depth.

In winter over the entire North Atlantic, the surface temperature minus 2°F (1.1°C) depth, when it exists, is found below 150 m. Although not included in this atlas, the Numerical Atlas tape has all-data means at standard hydrocast levels below 150 m. These means are biased by a preponderance of summer data, but they do provide an estimate of the depth of the permanent thermocline in months when no seasonal thermocline is present. In large areas of the North Atlantic, particularly in the Labrador Sea, Davis Strait, Baffin Bay, Greenland Sea, Denmark Strait, coast of Norway and North and Baltic Seas, temperature in winter increases with depth and there is no thermocline. (See T_0-T_{400} charts.)

The depth of the derived top of the thermocline is found by linear interpolation between monthly temperature means at the 100-ft (30-m) levels to 150 m, then between annual means at 183 m (600 ft), 200 m, 244 m (800 ft), 250 m, 300 m, 305 m (1000 ft), 350 m, 366 m (1200 ft), 400, 500, 600, 700, 800, 900, and 1000 m. To accommodate this depth range without sacrificing the resolution available in the surface layer, the contour interval on the thermocline charts changes from 50-ft (15-m) above 150 m to 100-m intervals below 200 m.

The charts showing the temperature difference between the surface and 400 ft (T_0-T_{400}) estimate the strength of the thermocline gradient confined between the top of the thermocline and 400 ft (120 m). T_0-T_{400} charts, however, give no indication of middepth minima or maxima that occur in some areas where waters of different temperature and salinity characteristics are intermixed at depth.

The occurrences of middepth temperature minima or maxima can be seen on the charts of annual cycle curves. These charts are arranged in sets to show the spatial variation in the seasonal cycles. Each of the sets contains composites of different latitude sets to show the full range of latitudinal variations, and the entire set contains charts at 5°-latitude by 10°-longitude intervals with additional selected points along the coasts and within the irregular shapes of the many seas and gulfs.

The annual cycle curves are produced by computer by calculating weekly values from the sixth harmonic Fourier coefficients of the twelve monthly mean values.

The data distribution charts, produced by plotter, contain for each monthly and annual chart the combined number of BT and hydrocast observations on which the charts were based and show a significant decrease in sample size with depth. Many BT traces did not extend to 400- or 492-ft (120-m or 150-m) levels.

In 1° areas, where the sample size exceeds 1000, the letter M is used. No data number is included in areas where temperature values were taken from published mean temperature charts or where they have been developed subjectively.

Only a single chart gives the data distribution for all levels of the salinity charts because there is little change in sample size with depth between the surface and 150 m.

DATA SOURCES

The temperature charts in this atlas are based on means of individual observations listed in Table I and means extracted from published charts listed in Table II. Figure A presents the areal distribution of data sources and handling.

The primary temperature data source was the files of photographic prints of BT slides maintained at Woods Hole Oceanographic Institution (WHOI). Additional BT data not in the WHOI file were added from Texas A&M University for the Gulf of Mexico and Caribbean, and from the University of Miami for the Mediterranean and Black Seas. BT data for the Red and Arabian Seas, Persian and Bengal Gulfs, and north Indian Ocean were taken from the Scripps Institution of Oceanography (SIO) BT files. These data were included on Wyrtki's International Indian Ocean Expedition data tapes.

Additional processed BT data were provided to WHOI and SIO by the U.S. Navy Hydrographic Office (now the U.S. Naval Oceanographic Office) from 1955 to 1960 and by the National Oceanographic Data Center from 1960 to 1968.

In August, 1974, BT data digitized on the SIO digitizer and XBT data digitized by Fleet Numerical Weather Central were added to the Atlantic data deck south of 30°N.

It should be noted that the majority of the BT data used in this atlas was processed by WHOI or SIO, where a consistent effort has been made since 1942 to process BT data with a temperature adjustment so that the measurement, insofar as is possible, is both relatively (temperature-depth differences) and absolutely accurate.

Although it has been shown that the mechanical BT provides a reliable temperature-depth profile, the accuracy of the temperature may be biased by shifts in calibration either in the BT or in the reference temperature measurements made by mercury thermometers used to calibrate the BT slide when processed.

After screening and processing, the individual BT observations appear to be accurate within ±0.3°C and the means ±0.1°C. Year-to-year bias may remain in portions of the final fields since large areas are based on single-year observations and the total sample spans the years 1941-1970.

ts, produced by plotter, contain for
rt the combined number of BT and
which the charts were based and
n sample size with depth. Many BT
- or 492-ft (120-m or 150-m) levels.

ple size exceeds 1000, the letter M is
luded in areas where temperature
ished mean temperature charts or
ped subjectively.

he data distribution for all levels of
here is little change in sample size
face and 150 m.

this atlas are based on means of
d in Table I and means extracted
in Table II. Figure A presents the
urces and handling.

e data source was the files of
slides maintained at Woods Hole
HOI). Additional BT data not in the
exas A&M University for the Gulf of
rom the University of Miami for the
s. BT data for the Red and Arabian
ulfs, and north Indian Ocean were
itution of Oceanography (SIO) BT
ed on Wyrtki's International Indian
s.

ta were provided to WHOI and SIO
aphic Office (now the U.S. Naval
1955 to 1960 and by the National
from 1960 to 1968.

digitized on the SIO digitizer and
Numerical Weather Central were
leck south of 30°N.

majority of the BT data used in this
I or SIO, where a consistent effort
rocess BT data with a temperature
surement, insofar as is possible, is
-depth differences) and absolutely

that the mechanical BT provides a
profile, the accuracy of the
y shifts in calibration either in the
ature measurements made by mer-
alibrate the BT slide when proces-

ssing, the individual BT observa-
within ±0.3°C and the means
ay remain in portions of the final
based on single-year observations
he years 1941-1970.

The secondary source of Atlantic data was hydrocasts collected by WHOI or selected from oceanographic data publications. These were merged with the BT data on an acquisition basis as part of the WHOI program for maintaining running mean tabulations of temperature at selected depths: surface, 100 ft (30 m), 150 ft (46 m), 250 ft (76 m), 328 ft (100 m) and 492 ft (150 m).

Hydrocast data in the Red and Arabian Seas and Bay of Bengal included all data collected by Wyrtki from the International Indian Ocean Expedition.

The monthly sea surface temperature charts for the southern Indian Ocean were derived from data tapes provided by the U.S. National Weather Records Center, Asheville, North Carolina. Means covered data collected between 1853 and 1968.

Because the data coverage in some regions and months was insufficient to produce satisfactory fields, additional temperature means were tabulated from previously published atlases and the values were treated as if they were means of individual observations.

The temperature data in the various geographic areas were subjected to somewhat different procedures, which will be described in the data preparation section.

TABLE I

Source of Individual Observations By Governments and Agencies

Part A. BT observations (1941-1970) 1,134 ships contributing in Atlantic Ocean, Mediterranean, Adriatic, Aegean, Black, Caribbean Seas, and Gulf of Mexico; 209 ships contributing in Red and Arabian Seas, Aden and Persian Gulfs, Bay of Bengal, and Pacific Ocean east of 100°W.

Australia
Commonwealth Scientific and Industrial Research Organization (CSIRO) Division of Fisheries and Oceanography
Canada
Fisheries Research Board of Canada, Atlantic Oceanographic Group, Halifax, Nova Scotia
Colombia
Colombian Navy, Buenaventura
India
University of Madras, Madras
Peru
Instituto del Mar Peru, Lima
United Kingdom
Royal British Navy
United States
Fish and Wildlife Service, Bureau of Commercial Fisheries (now National Marine Fisheries Service), National Oceanic and Atmospheric Administration (NMFS, NOAA) laboratories at Woods Hole, Massachusetts; Gloucester, Massachusetts; and Boothbay Harbor, Maine
Lamont-Doherty Geological Observatory, Columbia University, Palisades, New York
Naval Oceanographic Office, Bay St. Louis, Mississippi
Naval Ordnance Laboratory, Silver Springs, Maryland
Navy Ships of Opportunity
Rosenstiel School of Marine and Atmospheric Sciences, University of Miami, Miami, Florida

Texas Agricultural and Mechanical University, College Station, Texas
University of California, Scripps Institution of Oceanography, La Jolla, California
University of Washington, Division of Oceanography, Seattle, Washington
U.S. Coast and Geodetic Survey
U.S. Coast Guard
U.S. Navy
Woods Hole Oceanographic Institution, Woods Hole, Massachusetts

Part B. XBT data (1966-1974)

United States

Fleet Numerical Weather Central (FNWC) Monterey, California (data digitized at FNWC, but collected by numerous U.S. ships)

Part C. Selected hydrocast station data (1900-1969)

Canada

Canadian Oceanographic Data Center Special Reports (45 reports published 1961-1969)
Fisheries Research Board of Canada, Atlantic Oceanographic Group, Halifax, Nova Scotia (3 reports published 1957-1964)

International

EQUALANT I and II (EQI, EQII), 1963-1964
National Oceanographic Data Center hydrocast listings
International Council for the Exploration of the Sea
Bulletin Hydrographique (BH), 1930-1956, Charlottenlund Slot
ICES Oceanographic Data Lists (ICES), 1957-1959, Charlottenlund Slot
International Geophysical Year (IGY), 1957-1958
National Oceanographic Data Center hydrocast listings
International Indian Ocean Expedition (IIOE), 1960-1966
Wyrtki Indian Ocean hydrocast tape (1906-1967)
Nations contributing data in the above publications and data listings:
Argentina IGY, EQI, EQII
Australia IGY, IIOE
Belgium ICES
Brazil IGY, EQI, EQII
Canada BH, IGY
Congo EQI, EQII
Dahomey ICES
Estonia BH
Finland BH, IGY
France BH, ICES, IIOE
German Federal Republic BH, ICES, IGY, IIOE
Iceland IGY
India IIOE
Indonesia IIOE
Ireland BH, ICES
Italy BH, ICES, IGY
Ivory Coast EQI, EQII
Japan IIOE
Latvia BH
Malagasy Republic IIOE
Netherlands BH, ICES, IIOE, IGY
Nigeria EQI, EQII, IGY
New Zealand IGY
Northern Ireland IIOE
Norway BH, ICES, IIOE, IGY
Pakistan IIOE
Poland BH, ICES
Portugal BH, ICES, IIOE
South Africa IGY, IIOE
Spain BH, ICES, EQI, EQII
Sweden BH, ICES, IIOE
Thailand IIOE, IGY
Union of Soviet Socialist Republics ICES, EQI, EQII, IGY, IIOE
United States BH, ICES, IGY, IIOE, EQI, EQII
Yugoslavia IGY

United States

University of Washington Technical Report no. 185 Vol I-II, 1967
U.S. Coast Guard Bulletins
Ice Patrol hydrocast listings (17 reports published 1931-1959)
Weather station hydrocast listings (29 reports published 1963-1970)
U.S. Coast Guard Report of *Chelan* Expedition, 1934
U.S. Navy Hydrographic Office, H.O. Pub. 617B-G, 1949-1954; H.O. Pub. 618A-C, 1950-1953; TR. 58, 1956

TABLE II

Sources of Temperature Means or Analyzed Cruise Data By Governments, Agencies, or Authors

Germany

Schott, G., Geographie des Indischen und Stillen Ozeans, 1935.
Schott, G., Geographie des Atlantischen Ozeans, 1942.
Tomczak, G. and E. Goedecke, Monatskarten der temperatur der Nordsee, 1962.
Tomczak, G. and E. Goedecke, Die thermische schichtung der Nordsee auf grund der mittleren jahresganges der temperatur, 1964.
Lenz, W., Monatskarten der temperatur der Ostsee, 1971.

International

Dietrich, G., Mean monthly temperature and salinity of the surface layer of the North Sea and adjacent waters from 1905-1954, 1962.

Netherlands

Koninklijk Nederlandsch Meteorologisch Instituut, Red Sea and Gulf of Aden oceanographic data, 1949.
Koninklijk Nederlandsch Meteorologisch Instituut, Indian Ocean oceanographic and meteorological data, 1952.
Koninklijk Nederlandsch Meteorologisch Instituut, The Mediterranean oceanographic and meteorological data, 1957.

United States

Navy Hydrographic Office, World atlas of sea surface temperatures, 1944.
Fuglister, F., Atlantic Ocean atlas, 1960.
McLellan, ., The waters of the Gulf of Mexico as observed in 1958 and 1959, 1960.
Cochrane, J., Investigations of the Yucatan Current, 1961.
Cochrane, J., Yucatan Current, 1963.
Wust, G., Stratification and circulation in the Antillean-Caribbean Basins, 1964.
LaViolette, P. and C. Mason, Monthly charts of mean, minimum and maximum sea surface temperatures of the

Northern Ireland IIOE
Norway BH, ICES, IIOE, IGY
Pakistan IIOE
Poland BH, ICES
Portugal BH, ICES, IIOE
South Africa IGY, IIOE
Spain BH, ICES, EQI, EQII
Sweden BH, ICES, IIOE
Thailand IIOE, IGY
Union of Soviet Socialist Republics ICES, EQI, EQII, IGY, IIOE
United States BH, ICES, IGY, IIOE, EQI, EQII
Yugoslavia IGY

...d States

University of Washington Technical Report no. 185 Vol. I-II, 1967
U.S. Coast Guard Bulletins
  Ice Patrol hydrocast listings (17 reports published 1931-1959)
  Weather station hydrocast listings (29 reports published 1963-1970)
U.S. Coast Guard Report of *Chelan* Expedition, 1934
U.S. Navy Hydrographic Office, H.O. Pub. 617B-G, 1949-1954; H.O. Pub. 618A-C, 1950-1953; TR. 58, 1956

TABLE II

Sources of Temperature Means or Analyzed Cruise Data By Governments, Agencies, or Authors

...rmany

Schott, G., Geographie des Indischen und Stillen Ozeans, 1935.
Schott, G., Geographie des Atlantischen Ozeans, 1942.
Tomczak, G. and E. Goedecke, Monatskarten der temperatur der Nordsee, 1962.
Tomczak, G. and E. Goedecke, Die thermische schichtung der Nordsee auf grund der mittleren jahresganges der temperatur, 1964.
Lenz, W., Monatskarten der temperatur der Ostsee, 1971.

...ernational

Dietrich, G., Mean monthly temperature and salinity of the surface layer of the North Sea and adjacent waters from 1905-1954, 1962.

...therlands

Koninklijk Nederlandsch Meteorologisch Instituut, Red Sea and Gulf of Aden oceanographic data, 1949.
Koninklijk Nederlandsch Meteorologisch Instituut, Indian Ocean oceanographic and meteorological data, 1952.
Koninklijk Nederlandsch Meteorologisch Instituut, The Mediterranean oceanographic and meteorological data, 1957.

...ited States

Navy Hydrographic Office, World atlas of sea surface temperatures, 1944.
Fuglister, F., Atlantic Ocean atlas, 1960.
McLellan, H., The waters of the Gulf of Mexico as observed in 1958 and 1959, 1960.
Cochrane, J., Investigations of the Yucatan Current, 1961.
Cochrane, J., Yucatan Current, 1963.
Wust, G., Stratification and circulation in the Antillean-Caribbean Basins, 1964.
LaViolette, P. and C. Mason, Monthly charts of mean, minimum and maximum sea surface temperatures of the Indian Ocean, 1967.
Naval Oceanographic Office, Oceanographic atlas of the North Atlantic, Section 2 physical properties, 1967.
Miller, A., P. Tchernia, H. Charnock and D. McGill, Mediterranean Sea atlas, 1970.
Wyrtki, K., Oceanographic atlas of the *International Indian Ocean Expedition*, 1971.
Robinson, M., Monthly mean sea surface and subsurface temperature and depth of the top of the thermocline Mediterranean, Black and Red Seas, 1973.
Robinson, M., Monthly mean sea surface and subsurface temperature and depth of the thermocline Red Sea, 1973.
Robinson, M., Atlas of monthly mean sea surface and subsurface temperature and depth of the top of the thermocline Gulf of Mexico and Caribbean Sea, 1973.
U.S. Navy, Marine climatic atlas of the world, vol. 1, North Atlantic Ocean, 1974.
Robinson, M. Atlas of North Pacific monthly mean tempertures and mean salinities of the surface layer, 1976.

ANALYSIS PROCEDURE

The basic premise of the data analysis is that, given an adequate data distribution in time and space, a smooth annual cycle temperature curve can be constructed for every latitude-longitude-depth intersection in the analysis grid. To make the task of creating monthly values for each depth, latitude, and longitude feasible on an oceanwide basis, computer programs were developed to interpolate and smooth the data. Although these programs created values that were computationally correct, the results based only on observed data did not preserve known oceanographic features in low-data-density and coastal areas. To overcome the inadequacies in the data distribution and to maintain characteristic coastal gradients, subjective analysis was used to derive additional input data so that the computer solutions, bounded by a combination of real and derived values, would produce realistic numerical fields.

To process the main Atlantic area 5°S to 65°N on the SIO computer, using the programs developed by C.F. Sprague, the data were separated in 1965 into six 40° × 40° areas that overlapped 5°. The Gulf of Mexico and Caribbean Sea required separate processing and the Mediterranean Sea was divided into two overlapping areas. These early runs were used to edit the data horizontally and to discover areas requiring subjective analysis.

In 1967, the programs were converted by M. McLennan to allow the processing of an 80° × 80° area on the Fleet Numerical Weather Central computer. The major reanalysis that followed divided the Atlantic into three major runs, processing the Gulf of Guinea and the regions north of the Ireland-to-Greenland line as separate overlapping areas, but again major data problems were encountered.

In 1968, a computer program was written by R. Bauer and N. Perdue to produce contour charts on a Mercator projection. The plotting program also included logic to compute annual means and ranges for each level from the monthly values, temperature differences between levels, and a depth for the top of the thermocline so that all analysis results could be quickly reviewed. Additionally, to assist in subjective analysis, programs were written to plot time-temperature distributions and depth-temperature profiles of the observed data and means, to plot third through sixth harmonic curves, and to list and edit the

data file. These programs greatly reduced the clerical effort and also increased the pace of the project.

In 1972 the program was again upgraded by R. Bauer so that a matrix of 190° of longitude by 80° of latitude could be processed. This eliminated internal boundaries in the Atlantic and made it possible to prepare the contour charts over the entire fields for use in drafting the final atlas.

The salinity charts were produced in 1972 using the same basic computer methods developed for the temperature data, and they were processed as a single field 5°S to 72°N, 80°W to 100°E. The western Caribbean Sea and the Gulf of Mexico were included in the Pacific run, which extended to 75°W with a 5° analysis area overlap.

TEMPERATURE DATA PREPARATION

• ATLANTIC OCEAN

Running mean temperature values, by months, by 1° quadrangles at surface, 30, 46, 76, 100, and 150 m, and the number of observations on which they were based are maintained at WHOI from temperature readings tabulated on the backs of BT cards and from published hydrocast data. The means and sample sizes were hand tabulated by Schroeder and forwarded to SIO, where they were keypunched. Only a part of these data has been digitized in NODC format, but efforts are underway to digitize the remainder.

When the first computer runs were available in 1966-67, covering the areas 5°S to 65°N, 80°W to 10°E, excluding the Caribbean and Mediterranean Seas, it was evident that in areas of numerous data the computer programs did provide a realistic picture of the temperature structure. In areas of sparse data, such as the northern seas in winter, areas of tight gradients along the continental slopes, and in narrow gulfs, the programs did not produce valid results. After hand contouring the 1152 computer output sheets, the need to bound the solutions along all coasts and along northern and southern boundaries was recognized. Schroeder undertook the production of these subjective values beginning in 1968 by sketching time curves through available data and using published atlases or analyzed data fields to guide her choice of interpolated values. Means of real data were altered to a midmonth point where necessary.

Working from the southern tip of Florida clockwise around the Atlantic basin, by the spring of 1971 Schroeder had completed edge values around Africa, then across the Atlantic along 4°S to Brazil but had not done the South American coast. This 3-year subjective analysis effort produced complete sets of monthly values for 1,129 1° areas. At this point, the entire set of Atlantic data was reanalyzed, using the revised programs that included the calculation of the depth of the thermocline, and a complete set of computer plots was produced. In reviewing the thermocline plots, major discontinuities were discovered between fields at 150 ft (46 m) and those at 100 ft (30 m) above and 250 ft (76 m) below. These inconsistencies had escaped notice during the review of the hand-contoured horizontal charts but became obvious when the values were compared vertically. The discontinuities were caused by the fact that no attempt had been made to derive a value from the hydrocast data for the BT depths of 150 ft (46 m) when hydrocast data were added into the WHOI 1° monthly running means. Frequently 250 ft (76 m) was also omitted from standard hydrocasts. There were two problems: first, when data from both sources were present, the mean at 150 ft (46 m) might be inconsistent with the means above and below; and second, if only hydrocast data were available, no temperature value would be present at 150 ft (46 m) and the horizontal space interpolation program would produce a missing value inconsistent with those above and below. To correct these problems, the raw data means had to be examined and corrected where necessary.

By January 1973, this work was complete and corrections were forwarded to SIO for keypunching. In the new runs made in March, the northern regions now were satisfactory, but because of the paucity of data in the tropical Atlantic the results were still poor. Several attempts at reanalysis of the data by varying areas where one-dimensional and two-dimensional interpolation was used were to no avail. The results did not portray the vertical or horizontal structure that could be expected to be associated with the Atlantic equatorial current system.

Support for reanalysis of the Equatorial Atlantic was received from National Marine Fisheries Service (NMFS-NOAA), and subjective horizontal and time-curve interpolations were undertaken by Robinson.

By the end of 1975, after the addition of 3800 new BT and XBT obervations and a great number of subjective analysis values, runs were made that yielded satisfactory results.

The ice lines on the North Atlantic sea surface temperature charts are taken from the U.S. Navy Marine Climatic Atlas of the World, volume 1, North Atlantic (1974). The line marks the extent of 6/8 ice coverage by close pack ice. The ice line crosses isotherms in both this atlas and the source atlas because the sea ice drifts into and through areas of warmer and more saline surface water.

• CARIBBEAN AND GULF OF MEXICO AREAS

Three separate runs were made of the Caribbean Sea and Gulf of Mexico areas. In 1968 the first run was made based on WHOI data tabulations. There were many gaps in the data, and it was discovered that none of the Texas A & M BT data were included in the WHOI files. John Cochrane loaned Texas A & M's BT files to SIO, and temperatures from 16,000 BT traces were tabulated and a second run was made. Although these results were superior to the first, serious data gaps still existed. The subjective work of developing edge values and filling data gaps by developing time curves at selected points over the entire area was done at SIO by Robinson with the aid of previously published atlases and papers, which are listed in Table II. By 1970 this work was completed and new satisfactory runs were made. In March 1973 an interim atlas covering these areas at 100-ft (30-m) levels in °C was issued by SIO with support from NMFS-NOAA.

• MEDITERRANEAN AND BLACK SEAS

The primary data sources for these areas were the WHOI BT and hydrocast files. Additional BT and hydrocast observations were obtained from Rosenstiel School of Marine and At-

1

ı hydrocast data were added into the
means. Frequently 250 ft (76 m) was
ard hydrocasts. There were two
from both sources were present, the
ght be inconsistent with the means
ond, if only hydrocast data were
alue would be present at 150 ft (46 m)
terpolation program would produce
t with those above and below. To cor-
r data means had to be examined and

work was complete and corrections
keypunching. In the new runs made
egions now were satisfactory, but
ta in the tropical Atlantic the results
tempts at reanalysis of the data by
imensional and two-dimensional in-
e to no avail. The results did not
izontal structure that could be ex-
th the Atlantic equatorial current

the Equatorial Atlantic was received
eries Service (NMFS-NOAA), and
ne-curve interpolations were under-

he addition of 3800 new BT and XBT
mber of subjective analysis values,
d satisfactory results.

h Atlantic sea surface temperature
.S. Navy Marine Climatic Atlas of
Atlantic (1974). The line marks the
y close pack ice. The ice line crosses
and the source atlas because the sea
eas of warmer and more saline sur-

F OF MEXICO AREAS

made of the Caribbean Sea and Gulf
first run was made based on WHOI
many gaps in the data, and it was
Texas A & M BT data were included
rane loaned Texas A & M's BT files
om 16,000 BT traces were tabulated
ade. Although these results were
data gaps still existed. The subjec-
e values and filling data gaps by
elected points over the entire area
nson with the aid of previously
s, which are listed in Table II. By
ed and new satisfactory runs were
erim atlas covering these areas at
s issued by SIO with support from

BLACK SEAS

for these areas were the WHOI BT
al BT and hydrocast observations
stiel School of Marine and At-

mospheric Sciences, University of Miami. Sea surface temperature means from the U.S. National Weather Records Center's marine decks, the Netherlands Meteorological Institute's publications and other published sources listed in Table II were used to fill in edge values and data gaps. Seasonal curves were developed along coastal and selected points to fill in data gaps and edit the raw data means by Robinson. Time curves for all 1° quadrangles in the Adriatic and Black Sea and most of the Aegean Sea were developed.

Successful final computer runs of these data were made in 1970. In August 1973 FNWC issued an interim atlas covering these areas and the Red Sea at 100-ft (30-m) levels in °F.

- **RED AND ARABIAN SEAS, ADEN AND PERSIAN GULFS, AND BAY OF BENGAL**

Data in these areas were based on the BT files at SIO collated by Wyrtki, University of Hawaii, with hydrocast data from the International Indian Ocean Expedition. The Red Sea, Gulf of Aden, and Persian Gulf, except for plotting, were handled subjectively and time curves were developed for all 1° quadrangles. The computer interpolation programs do not successfully operate in narrow, diagonal configurations. Additional areas along the Oman Coast, off the west coast of India, and in the Bay of Bengal, as shown in Figure A, were subjectively analyzed. A separate Red Sea Atlas was published in °C at depths of 0, 30, 46, 76, 100 and 150 m (Robinson, 1973, 1974.)

Except along the main ship routes in the Arabian Sea and Bay of Bengal, data gaps were very large in both space and time as data distribution charts indicate. In these areas analysis was carried out at 100-ft levels. Programs were written to combine data in bimonthly means. These means were then analyzed horizontally and the fields evaluated. Additional subjective values were developed and a second successful run made. Next, a third harmonic curve was fitted to these six means and twelve monthly values produced from the curves. The fields were computer plotted and evaluated together with plots of the harmonic time curves. The results were consistent with previous subjective analyses done by Robinson (1967) and Wyrtki (1971) in the area, and they appear to be reasonable models of the surface layer temperature structure.

- **INDIAN OCEAN**

Sea surface temperature means from the U.S. National Weather Records Center's marine deck were analyzed to produce monthly mean sea surface charts covering the Indian Ocean from 20°E to 150°E, 5°S to 48°S. These data were analyzed using the basic two-dimensional interpolation, space smoothing, and time smoothing programs.

At 5°S, contours on these charts agree with those produced from BT and hydrocast data. Some smoothing was required to make them fit, but the adjustments were primarily of the order of 0.1° to 0.2°C because the temperature fields in the region are very flat and the displacements of the isotherms in space were small. Wooster, Schaefer and Robinson (1967) published sea surface temperature charts of the north Indian Ocean to 5°S based on National Records data. The isotherms in that publication are in remarkably close agreement to those of the BT data version in this atlas. Coastal gradients, particularly in the Somali current region and along the Oman Coast, were tighter in the BT version. Similar lessening of

2

current and coastal gradients may occur in the South Indian Ocean surface temperature charts.

• **NORTH AND BALTIC SEAS**

The Deutsche Hydrographische Zeitschrift, Hamburg, kindly gave us permission to reproduce their definitive temperature charts for the North Sea published by Tomczak and Goedecke (1962, 1964), and for the Baltic by Lenz (1971).

In order to complete our data tapes, data by 1° quadrangles were read and tabulated from the published monthly charts in the center of the quadrangles. In the North Sea this sufficed for the 30- and 60-m levels. Fortunately, monthly vertical sections were also published for each latitude. Temperature values were read from the sections at midpoint of each longitude for levels 0, 90, and 120 m. Published contours at 7.5, 80, 100 m and at the bottom were used as guides in contouring the temperature fields, allowing us to provide more detail in the contours than our 1° derived values could provide. The annual cycle curves produced from the derived values are consistent with the time continuity of the original charts.

In the Baltic, monthly horizontal temperature charts were available at 0, 30, and 60 m, which could be tabulated directly. Values for 90, 120 and 150 m were interpolated from the published vertical sections. For the months January through April in the Gulf of Bothnia, values were extrapolated from whatever values were shown on the horizontal charts at 80 and 100 m, and at the bottom, on the assumption that the May deep values were approximately equal to the minimum values, reached in midwinter but not as early as December. Ice lines in this area were taken from Lenz (1971).

• **IRISH SEA**

Surface temperatures only were available for the Irish Sea. Permission was kindly given by the International Council for the Exploration of the Sea (ICES) to reproduce surface temperatures for the Irish Sea from their 1962 atlas covering the North and Irish Seas and authored by Dietrich. The same method of digitizing values for each 1° quadrangle was used as for the North and Baltic Seas.

SALINITY DATA PREPARATION

Salinity and temperature data on the NODC 1969 hydrocast tapes were extracted at standard NODC depth levels using the first observed values less than 10 m for the surface observation when a surface value did not exist. The salinity values at 100-ft (30-m) intervals were interpolated from each observation to provide salinity distributions for levels matching the temperature analysis, using the four-point double-limb quadratic interpolation whenever possible. If either of the limbs or the means lay outside the range of the adjacent values, linear interpolation was used.

The individual observations were then tabulated for each 10° Marsden square on temperature-depth and salinity-depth plots. From these plots a table of minimum and maximum values allowable at each level in each Marsden square was created. The table was then used to screen observations before they were included in the all-data 1° quadrangle means. When a hydrocast contained three or more values outside the established limits, the entire observation was deleted.

The mean values were printed as temperature-depth and salinity-depth profiles on a composite plot for each 5° Marsden square. Additionally, the density structures were printed for the 10° square. After reviewing the results the temperature and salinity limit table was revised to further restrict the data accepted, and the means were recomputed.

The means, standard deviations, minimum and maximum values, and sample sizes were listed for all 1° quadrangles that contained density instabilities. The means were then edited by deleting a portion of the structure, or by inserting a value obtained by using vertical linear interpolation between existing values to replace the questionable value. Vertical interpolation was used to obtain a value that fit with the data above and below when the discontinuity was caused by a change in sample size.

When all corrections had been made the mean values were processed through the first two steps of the main analysis program: horizontal interpolation and smoothing (omitting the time smoothing). Means that were not in space context with surrounding means were deleted and the fields were then reanalyzed.

GEOGRAPHIC AND TIME ANALYSIS PROGRAM

The main computer analysis involved five separate computations: (1) linear one- or two-dimensional horizontal interpolation; (2) horizontal smoothing; (3) time smoothing; (4) adjustment of false gradients; and (5) interpolation to 100-ft levels. Additionally, the program produced horizontal and time-series listings of the data.

The first two steps of this analysis operated on each level and month independently. The third step operated on twelve monthly values at each level in time, and the last two operated on values for a single month and position vertically.

• **INTERPOLATION**

In the tropical regions, one-dimensional linear interpolation along a latitude was used to fill in the horizontal fields. In the remaining areas, two-dimensional interpolation was used. The solution for the two-dimensional interpolation used an iterative technique modified to ignore cells that represented land areas (Peaceman and Rachford, 1953). Convergence was assumed when the maximum relative change between iterations was less than 0.0005°C and the maximum difference was less than 0.005°C. In two-dimensional interpolation, an interpolated value was equal to the average of the neighboring values (either observed or interpolated) in the columns and rows. Observed values were not altered in either one- or two-dimensional interpolation.

• **SPACE SMOOTHING**

The space smoothing process replaces each value, either observed or interpolated, by the values determined by a least-

d in the all-data 1° quadrangle means. When a hydrocast ined three or more values outside the established limits, ntire observation was deleted.

· mean values were printed as temperature-depth and ty-depth profiles on a composite plot for each 5° Marsden e. Additionally, the density structures were printed for the quare. After reviewing the results the temperature and ty limit table was revised to further restrict the data ac-l, and the means were recomputed.

· means, standard deviations, minimum and maximum s, and sample sizes were listed for all 1° quadrangles that ined density instabilities. The means were then edited by ng a portion of the structure, or by inserting a value ob-l by using vertical linear interpolation between existing s to replace the questionable value. Vertical interpolation sed to obtain a value that fit with the data above and below the discontinuity was caused by a change in sample size.

en all corrections had been made the mean values were ssed through the first two steps of the main analysis am: horizontal interpolation and smoothing (omitting the smoothing). Means that were not in space context with sur-ling means were deleted and the fields were then lyzed.

GRAPHIC AND TIME ANALYSIS PRO-AM

main computer analysis involved five separate tations: (1) linear one- or two-dimensional horizontal in-ation; (2) horizontal smoothing; (3) time smoothing; (4) ad-ent of false gradients; and (5) interpolation to 100-ft levels. onally, the program produced horizontal and time-series s of the data.

first two steps of this analysis operated on each level and independently. The third step operated on twelve ly values at each level in time, and the last two operated ues for a single month and position vertically.

ERPOLATION

he tropical regions, one-dimensional linear interpolation a latitude was used to fill in the horizontal fields. In the ing areas, two-dimensional interpolation was used. The n for the two-dimensional interpolation used an iterative que modified to ignore cells that represented land areas man and Rachford, 1953). Convergence was assumed he maximum relative change between iterations was less .0005°C and the maximum difference was less than '. In two-dimensional interpolation, an interpolated value ual to the average of the neighboring values (either ed or interpolated) in the columns and rows. Observed were not altered in either one- or two-dimensional inter-n.

CE SMOOTHING

space smoothing process replaces each value, either ed or interpolated, by the values determined by a least-squares fit to a straight line of the three points centered, where possible, at the point being smoothed. The process is carried through, first along latitudes and then along longitudes. In order to retain gradients in coastal areas, any 1° quadrangle could be flagged as a constant. When flagged, the values were used in the space smoothing but were not replaced with a smoothed value.

• TIME SMOOTHING

After horizontal interpolation and smoothing, the monthly values for each level at the 1° quadrangle location were smoothed in time. The time-smoothed values were computed, using coefficients for the first three harmonics of the Fourier function fitted to the monthly space-smoothed values. Data that were flagged as constants were not resmoothed. The time smoothing procedure adjusts means to mid-month values.

• ADJUSTMENT OF GRADIENTS

In this atlas the horizontal gradients in nearshore areas were maintained by a combination of subjective and computer analyses. The coastal values were preanalyzed and held constant throughout the main analysis run.

The analysis program may generate vertical gradients that are not present in the observed data by interpolation over different distances at various levels and by time smoothing at locations where the true subsurface annual cycle curve has a cusp or pointed peak shape that third harmonic curves cannot produce.

Interpolation caused significant problems in early runs in areas near the continental shelves with low data coverage. To rectify the problem, values out to the 492 ft (150 m) depth contour were subjectively analyzed and held constant through later analysis runs.

The other type of inconsistency occurs from October through January in the subsurface levels north of 30°N. In these areas the subsurface third harmonic curves tend to overshoot the surface curve, creating false positive temperature gradients. These gradients were removed by making the water column isothermal in selected months. Real positive gradients, which occur in subarctic regions, in coastal regions, and along water-mass boundaries, were not altered by the programs. In many regions the extent of the positive gradient was less than the contour interval and cannot be identified on the horizontal charts.

• INTERPOLATION TO 100-FT (30-M) LEVELS

In the Atlantic basin where WHOI data were used as the primary source file, the analysis program was used for a fifth function, to interpolate from WHOI levels to 100-ft (30-m) levels. The interpolation used was a simple linear interpolation using 0, 30, and 150 m directly for 0, 100 and 492 ft and interpolation for 200 ft (60 m), 300 ft (90 m), and 400 ft (120 m) between the 30-, 46-, 76-, 100-, and 150-m levels.

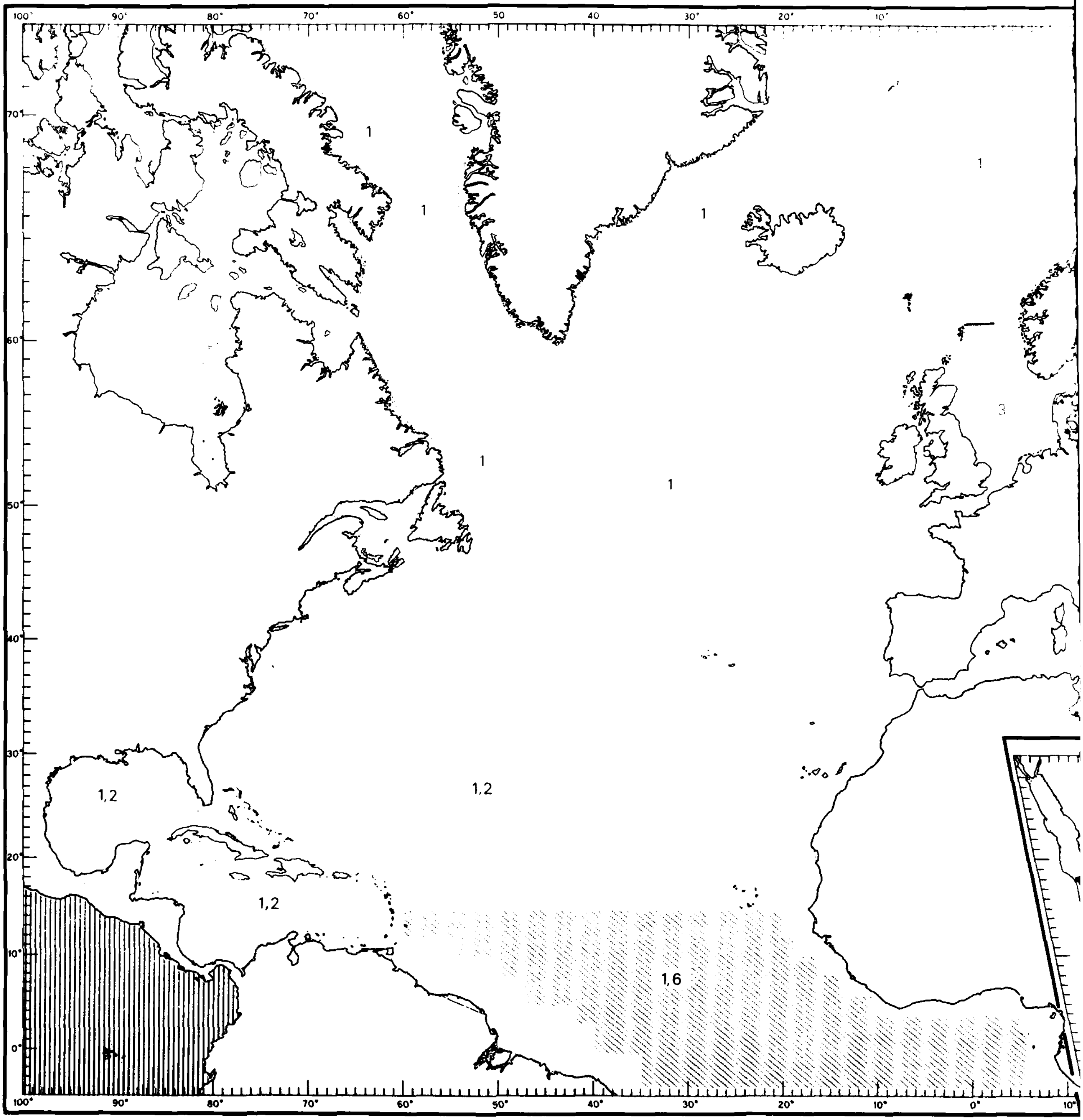
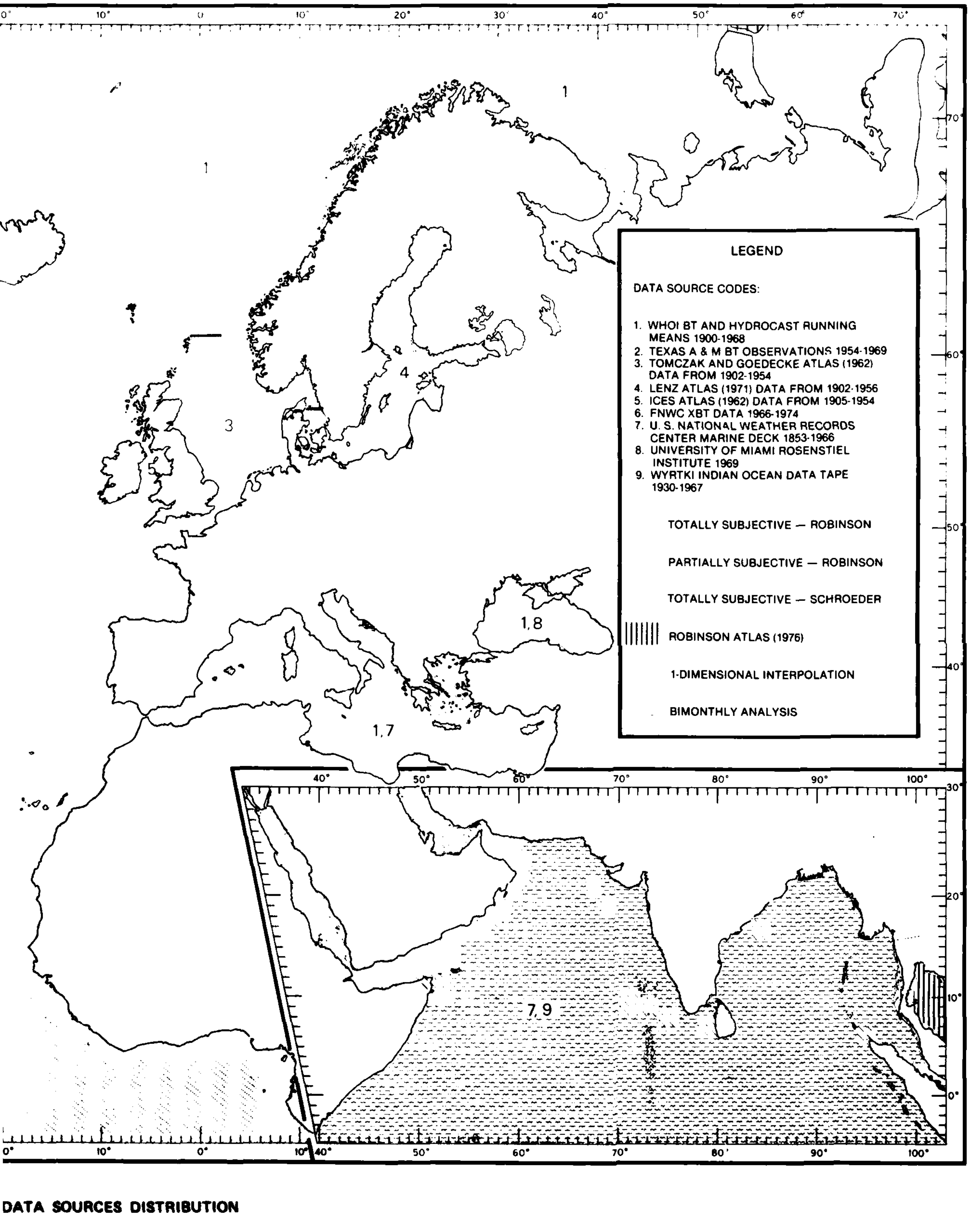


FIGURE A. DATA SOURCES DISTRIBUTION



DATA SOURCES DISTRIBUTION

REFERENCES

Aliverti, G., M. Picotti, L. Trotti, A. De Maio, O. Lauretta, and M. Moretti, *Atlante del Mar Tirreno*, Consiglio Nazionale delle Ricerche, Rome, and Instituto Universitario Navale, Naples, 242 pp., 1968.

Bjerknes, V., Uber einen hydrodynamischen fundamentalsatz und seine anwendung besonders auf die mechanik der atmosphare und des weltmeeres, Kungl.Svenska Vetensk. *Akademiens Handlingar, 31 (4)*, Stockholm, 35 pp., 1898.

Bjerknes, V. and J. Sandstrom, Dynamic meteorology and hydrography, Part 1, Statics and Part 2, Kinematics, *Carnegie Inst. Wash. Pub. 88*, 321 pp., 1910-1911.

Bohnecke, G., Atlas zu temperatur, salzgehalt und dichte an der oberflache des Atlantischen Ozeans, *Deutsche Atlantische Expedition Meteor 1925-27, Wiss. Erg., 6 (2)*, Verlag von Walter de Gruyter, Berlin u. Leipzig, 81 pp., 1936.

Buchan, A., Report on oceanic circulation, based on the observations made onboard H.M.S. *Challenger* and other observations, in *The voyage of the H.M.S. Challenger, a summary of the scientific results, part 2, appendix, physics and chemistry*, Part VIII, edited by J. Murray, Edinburgh, 70 pp., 1895.

Buchanan, J., Report on the specific gravity of samples of ocean water, observed onboard H.M.S. *Challenger* during the years 1873-1876, in *Report on the scientific results of the voyage of H.M.S. Challenger during the years 1873-1876, physics and chemistry, 1*, Part 2, edited by J. Murray, Edinburgh, 56 pp., 1884.

Buljan, M. and M. Zore-Armanda, Hydrographic data Adriatic Sea collected 1952-1964, *Acta Adriatica 12*, Inst. za Oceanogr. i Ribarstvo, Split, Yugoslavia, 437 pp., 1966.

Cochrane, J., Investigations of the Yucatan Current, *The A&M College of Texas, Dept. of Oceangr. and Meteor. Ref. 61-15F*, 4-7, 1961.

Cochrane, J., Equatorial undercurrent and related currents off Brazil in March and April 1963, *Science* 142, 669-671, 1963.

Cochrane, J., Yucatan Current, *The A&M College of Texas, Dept. of Oceanogr. and Meteor. Ref. 63-18A*, 6-11, 1963.

Cochrane, J., Low sea-surface salinity off northeastern South America in summer 1963, *J. Mar. Res. 27 (3)*, 327-334, 1969.

Colton, J. and R. Stoddard, Average monthly sea-water temperatures Nova Scotia to Long Island 1940-1959, *Serial Atlas of the Marine Environment, Folio 21*, American Geographical Society, New York, 124 pp., 1972.

Conseil International pour l'Exploration de la Mer, *Bulletin Hydrographique* (annual volumes for 1930-1956), Charlottenlund Slot, Denmark, 1931-1944, 1950-1962.

Conseil International pour l'Exploration de la Mer, *ICES Oceanographic Data Lists* (1957 data, Nos. 1-9 published 1963-1967; 1958 data, Nos. 1-12 published 1963-1967; 1959 data, Nos. 1-10 published 1964-1971), Charlottenlund Slot, Denmark, 1963-1971.

Deacon, M., *Scientists and the sea 1650-1900*, Academic Press, London and New York, 443 pp., 1971.

Dietrich, G., *Mean monthly temperature and salinity of the surface layer of the North Sea and adjacent waters from 1905 to 1954*, Conseil International pour l'Exploration de la Mer, Service Hydrographique, Charlottenlund Slot, Denmark, 170 pp., 1962.

Dietrich, G., *Atlas of the hydrography of the northern North Atlantic Ocean (winter and summer 1958)*, Conseil International pour l'Exploration de la Mer, Service Hydrographique, Charlottenlund Slot, Denmark, 357 pp., 1969.

Duing, W., The monsoon regime of the currents in the Indian Ocean, *International Indian Ocean Expedition Monograph No. 1*, East-West Center Press, Honolulu, 105 pp., 1970.

Fell, B., *America B.C.*, The New York Times Book Co., New York, 311 pp., 1976.

Fuglister, F., Average monthly sea surface temperatures of the western North Atlantic, *Papers in Physical Oceanography and Meteorology, 10 (2)*, M.I.T., Cambridge and Woods Hole Oceanogr. Inst., Woods Hole, Mass., 25 pp., 1947.

Fuglister, F., Atlantic Ocean atlas of temperature and salinity profiles and data from the International Geophysical Year of 1957-1958, *Woods Hole Oceanogr. Atlas Series Volume I*, Woods Hole, Mass., 209 pp., 1960.

Grant, A., Atlas of oceanographic sections: temperature, salinity, dissolved oxygen, silica 1965-1967, *A.O.L. Rep 68-5*, Bedford Institute of Oceanography, Dartmouth, Nova Scotia, 80 pp., 1968.

Helland-Hansen, B. and F. Nansen, The Eastern North Atlantic, *Geofys. Pub., 4 (2)*, Oslo, 147 pp., 1926.

Hesselberg, T. and H. Sverdrup, Die Stabilitatsverhaltnisse des seewassers bei vertikalen verschiebungen, *Bergens Museums Aarbok, 14-15 (15)*, 16 pp., 1915.

International Cooperative Investigations of the Tropical Atlantic (ICITA), *Oceanographic Atlas Vol. 1, EQUALANT I and EQUALANT II, UNESCO*, Paris, 289 pp., 1973.

Iselin, C., A study of the circulation of the western North Atlantic, *Popular Phys. Oceanogr., 4 (4)*, 101 pp., 1936.

Iselin, C., Preliminary report on long-period variations in the transport of the Gulf Stream system, *Pap. Phys. Oceanogr., 8 (1)*, 40 pp., 1940.

Knudsen, M., *Hydrographical tables*, G.E.C. Gad, Copenhagen, 63 pp., 1901.

Koninklijk Nederlandsch Meteorologisch Instituut, *Red Sea and Gulf of Aden oceanographic data, Publication 129*, Staatsdrukkerij-en-Uitgeverijvedrijf., 's.-Gravenhage, 26 pp., 1949.

Koninklijk Nederlandsch Meteorologisch Instituut, *Indian Ocean oceanographic and meteorological data, Publication 104*, Staatsdrukkerij-en-Uitgeverijvedrijf., 's.-Gravenhage 91 pp., 1952.

Koninklijk Nederlandsch Meteorologisch Instituut, *The Mediterranean oceanographic and meteorological data, Publication 138*, Staatsdrukkerij-en-Uitgeverijvedrijf., 's.-Gravenhage, 91 pp., 1957.

Krauss, W., Untersuchung uber die mittleren hydrographischen verhaltnisse an der meeresoberflache des nordlichen Nordatlantischen Ozeans, *Deutsche Atlantische Expedition Meteor 1925-27*, Wiss. Erg., 5 (3), Verlag von Walter de Gruyter, Berlin u. Leipzig, 451 pp., 1958.

LaViolette, P. and C. Mason, Monthly charts of mean, minimum and maximum sea surface temperatures of the Indian Ocean, *Naval Oceanogr. Off. Spec. Pub. SP-99*, Washington, D.C., 48 pp., 1967.

Lenz, W., Monatskarten der temperatur der Ostsee dargestellt fur verschiedene tiefenhorizonte, *Dtsch. Hydrogr. Zeit. Erg. Reihe B (4°) 11*, 141 pp., 1971.

Lumby, J., Salinity and temperature of the English Channel, *Fisheries Invest. Series II, 14 (3)*, Fisheries Laboratory, Lowestoft, Eng., 26 pp., 1935.

Mann, C., A. Grant and T. Foote, *Atlas of oceanographic sections-temperature, salinity and dissolved oxygen*, Bedford Institute of Oceanography, Dartmouth, Nova Scotia, 55 pp., 1965.

Maury, M., *The physical geography of the sea*, Harper and

1

ique, Charlottenlund Slot, Denmark, 357 pp., 1969.
z, W., The monsoon regime of the currents in the Indian Ocean, *International Indian Ocean Expedition Monograph No 1*. East-West Center Press, Honolulu, 105 pp., 1970.
B., *America B.C.*, The New York Times Book Co., New York, 311 pp., 1976.
ster, F., Average monthly sea surface temperatures of the western North Atlantic, *Papers in Physical Oceanography and Meteorology, 10 (2)*, M.I.T., Cambridge and Woods Hole Oceanogr. Inst., Woods Hole, Mass., 25 pp., 1947.
ster, F., Atlantic Ocean atlas of temperature and salinity profiles and data from the International Geophysical Year of 1957-1958, *Woods Hole Oceanogr. Atlas Series Volume I*, Woods Hole, Mass., 209 pp., 1960.
t, A., Atlas of oceanographic sections: temperature, salinity, dissolved oxygen, silica 1965-1967, *A.O.L. Rep. 68-5*, Bedford Institute of Oceanography, Dartmouth, Nova Scotia, 80 pp., 1968.
nd-Hansen, B. and F. Nansen, The Eastern North Atlantic, *Geofys. Pub., 4 (2)*, Oslo, 147 pp., 1926.
lberg, T. and H. Sverdrup, Die Stabilitatsverhaltnisse des seewassers bei vertikalen verschiebungen, *Bergens Museums Aarbok, 14-15 (15)*, 16 pp., 1915.
national Cooperative Investigations of the Tropical Atlantic (ICITA), *Oceanographic Atlas Vol. 1, EQUALANT and EQUALANT II, UNESCO*, Paris, 289 pp., 1973.
, C., A study of the circulation of the western North Atlantic, *Popular Phys. Oceanogr., 4 (4)*, 101 pp., 1936.
, C., Preliminary report on long-period variations in the transport of the Gulf Stream system, *Pap. Phys. Oceanogr., (1)*, 10 pp., 1940.
sen, M., *Hydrographical tables*, G.E.C. Gad, Copenhagen, 3 pp., 1901.
iklijk Nederlandsch Meteorologisch Instituut, *Red Sea and Gulf of Aden oceanographic data, Publication 129*, Staatsdrukkerij-en-Uitgeverijvedrijf., 's.-Gravenhage, 26 pp., 1949.
iklijk Nederlandsch Meteorologisch Instituut, *Indian Ocean oceanographic and meteorological data, Publication 04*, Staatsdrukkerij-en-Uitgeverijvedrijf., 's.-Gravenhage 1 pp., 1952.
iklijk Nederlandsch Meteorologisch Instituut, *The Mediterranean oceanographic and meteorological data, Publication 138*, Staatsdrukkerij-en-Uitgeverijvedrijf., 's.-Gravenhage, 91 pp., 1957.
ss, W., Untersuchung uber die mittleren hydrographischen erhaltnisse an der meeresoberflache des nordlichen Nordatlantischen Ozeans, *Deutsche Atlantische Expedition Meteor 1925-27*, Wiss. Erg., 5 (3), Verlag von Walter de Gruyter, Berlin u. Leipzig, 451 pp., 1958.
olette, P. and C. Mason, Monthly charts of mean, minimum and maximum sea surface temperatures of the Indian Ocean, *Naval Oceanogr. Off. Spec. Pub. SP-99*, Washington, D.C., 48 pp., 1967.
W., Monatskarten der temperatur der Ostsee dargestellt ur verschiedene tiefenhorizonte, *Dtsch. Hydrogr. Zeit. Erg. Reihe B (4°) 11*, 141 pp., 1971.
y, J., Salinity and temperature of the English Channel, *Fisheries Invest. Series II, 14 (3)*, Fisheries Laboratory, Lowestoft, Eng., 26 pp., 1935.
, C., A. Grant and T. Foote, *Atlas of oceanographic sections-temperature, salinity and dissolved oxygen*, Bedford Institute of Oceanography, Dartmouth, Nova Scotia, 5 pp., 1965.
y, M., *The physical geography of the sea*, Harper and Brothers, New York, 1855.
Mazeika, P., Mean monthly sea surface temperatures and zonal anomalies of the tropical Atlantic, *Serial atlas of the marine environment, Folio 16*, American Geographical Society, New York, 9 pp., 1968.
McLellan, H., The waters of the Gulf of Mexico as observed in 1958 and 1959, *The A&M College of Texas, Dept. of Oceanogr. and Meteor. Ref. 60-14T*, 17 pp., 1960.
Miller, A., P. Tchernia, H. Charnock and D. McGill, Mediterranean Sea atlas, *Woods Hole Oceanogr. Atlas Series Volume 3*, Woods Hole, Mass., 189 pp., 1970.
Murray, J., On the annual range of temperature in the surface waters of the ocean and its relation to other oceanographical phenomena, *Geograph. J.*, London, 1898.
Nowlin, W. and H. McLellan, A characterization of the Gulf of Mexico waters in winter, *J. Mar. Res. 25 (1)*, 29-59, 1967.
Parr, A., Report on hydrographic observations at a series of anchor stations across the Straits of Florida, *Bull. Bingham Oceanogr. Coll., 6 (3)*, 62 pp., 1937.
Peaceman, D., and H. Rachford, The numerical solution of parabolic and elliptic differential equations, *J. Soc. Indust. Appl. Math., 3*, 28-41, 1953.
Pillsbury, J., The Gulf Stream a description of the methods employed in the investigation, and the results of the research, *Annual Report of the Superintendent, U.S. Coast and Geodetic Survey for 1890, Appendix 10*, 538-579, 1890.
Prestwich, J., Tables of temperatures of the sea at different depths beneath the surface, *Philosophical Transactions of the Royal Society, 165 (2)*, 587-671, 1875.
Robinson, M., Atlas of monthly mean sea surface and subsurface temperature and depth of the top of the thermocline Gulf of Mexico and Caribbean Sea, *Scripps Inst. Oceanogr., Ref. 73-8*, Univ. Calif., La Jolla, 105 pp., 1973a.
Robinson, M., Monthly mean sea surface and subsurface temperature and depth of the top of the thermocline Mediterranean, Black and Red Seas, *Fleet Numerical Weather Central Tech. Note 73-3*, Monterey, Calif., 101 pp., 1973b.
Robinson, M., Monthly mean sea surface and subsurface temperature and depth of the thermocline Red Sea, *Fleet Numerical Weather Central Tech. Note 73-4*, Monterey, Calif., 117 pp., 1973c.
Robinson, M., Seasonal variation in temperature of the Red Sea, Symposium de l'Association Internationale des Sciences Physiques de l'Ocean (I.A.P.S.O.), *Pub. du Centre National Pour l'Exploitation des Oceans (CNEXO) Serie: Actes de colloques, 2*, 29-54, Paris, 1974.
Robinson, M., Atlas of North Pacific Ocean monthly mean temperatures and mean salinities of the surface layer, *Naval Oceanogr. Off. Ref. Pub. 2*, Washington, D.C., 194 pp., 1976.
Roufogalis, B., *Oceanographic conditions in the Aegean Sea*, Hellenic Navy Command, Hydrographic Service, Greece, 108 pp., 1970.
Schott, G., *Geographie des Indischen und Stillen Ozeans*, Verlag von C. Boysen, Hamburg, 452 pp., 1935.
Schott, G., *Geographie des Atlantischen Ozeans*, Verlag von C. Boysen, Hamburg, 438 pp., 1942.
Schroeder, E., North Atlantic temperatures at a depth of 200 meters, *Serial atlas of the marine environment, Folio 2*, American Geographical Society, New York, 22 pp., 1963.
Schroeder, E., Average monthly temperatures in the North Atlantic Ocean, *Deep Sea Research, 12*, 323-343, 1965.
Schroeder, E., Average surface temperatures of the western North Atlantic, *Bulletin of Marine Science, 16 (2)*, 302-323, 1966.

2

Smed, J., Monthly anomalies of the surface temperature in areas of the northern North Atlantic 1956-1961, Conseil International pour l'Exploration de la Mer, *Annales Biologiques, 19*, 17-21, 1964a.

Smed, J., Monthly anomalies of the surface salinity in the Celtic Sea during 1903-1958, Conseil International pour l'Exploration de la Mer, *Annales Biologiques, 19*, 50-53, 1964b.

Smith, E., A practical method for determining ocean currents, *Bull. U.S. Coast Guard, 14*, 50 pp., 1926.

Spilhaus, A., A bathythermograph, *J. Mar. Res., 1 (2)*, 95-100, 1938.

Sverdrup, H., M. Johnson and R. Fleming, *The oceans: their physics, chemistry, and general biology*, Prentice-Hall, Inc., New York, 1087 pp., 1942.

Tizard, T., Report on temperatures and general summary of Atlantic Ocean temperature, *H.M.S. Challenger, No. 7 Report on ocean soundings and temperatures, Atlantic Ocean*, 5-19, 1876.

Tizard, T., Remarks on the soundings and temperatures obtained in the Faroe Channel during the summer of 1882, *Proc. Roy. Soc., 35*, 202-226, 1883.

Tizard, T. and J. Murray, Exploration of the Faeroe Channel during the summer of 1880, *Proc. R. Soc. Edinb., 11*, 638-720, 1880-1882.

Tomczak, G. and E. Goedecke, Monatskarten der temperatur der Nordsee dargestellt fur verschiedene tiefenhorizonte, *Dtsch. Hydrogr. Zeit. Erg. Reihe B (4°) 7*, 111 pp., 1962.

Tomczak, G. and E. Goedecke, Die thermische schichtung der Nordsee auf grund des mittleren jahresganges der temperatur in ½° und 1°-felden, *Dtsch. Hydrogr. Ziet. Erg. Reihe B (4°) 8*, 182 pp., 1964.

U.S. Navy Hydrographic Office, World atlas of sea surface temperatures, *U.S. Navy Hydrogr. Off. Pub. 225*, Washington, D.C., 49 pp., 1944.

U.S. Naval Oceanographic Office, Oceanographic atlas of the North Atlantic, Section 2 Physical properties, *U.S. Naval Oceanographic Off. Pub. 700*, Washington, D.C., 296 pp., 1967.

U.S. Navy, Marine climatic atlas of the world, vol. 1, North Atlantic Ocean, *NAVAIR 50-1C-528*, 371 pp., 1974.

Van Riel, P., P. Groen and M. Weenink, Quantitative data concerning the statics of the east Indonesian waters, *Snellius Expedition, 2*, Part 7, 45 pp., 1957.

Von Arx, W., *An introduction to physical oceanography*, Addi-

1

0, *Proc. R. Soc. Edinb.*, *11*, 638-

., Monatskarten der temperatur
ır verschiedene tiefenhorizonte,
Reihe B (4°) 7, 111 pp., 1962.
. Die thermische schichtung der
ttleren jahresganges der temper-
n, *Dtsch. Hydrogr. Zeit. Erg.*
64.
ce, World atlas of sea surface
Hydrogr. Off. Pub. 225, Washing-

ice, Oceanographic atlas of the
Physical properties, *U.S. Naval*
on, Washington, D.C., 296 pp.,

tlas of the world, vol. 1, North
50 IC 528, 371 pp., 1974.
M. Weenink, Quantitative data
e east Indonesian waters, *Snell-*
45 pp., 1957.
to physical oceanography. Addi-
son-Wesley Publishing Co. Inc., Reading, Mass. and London, 422 pp., 1962.

Walford, L. and R. Wicklund, Monthly sea temperature structure from the Florida Keys to Cape Cod, *Serial atlas of the marine environment, Folio 15*, American Geographical Society, New York, 46 pp., 1968.

Wooster, W., M. Schaefer and M. Robinson, Atlas of the Arabian Sea for fishery oceanography, *Inst. Mar. Resources IMR Ref. 67-12*, Univ. Calif., 26 pp., 1967.

Wust, G. and A. Defant, Schichtung und zirkulation des Atlantischen Ozeans, *Deutsche Atlantische Expedition Meteor 1925-27, Wiss. Erg., 6*, Verlag von Walter de Gruyter, Berlin u. Leipzig, 103 pp., 1936.

Wust, G., Stratification and circulation in the Antillean-Caribbean Basins, Part 1, *Vema Research Series No. 2*, Lamont-Doherty Geological Observatory, Columbia University Press, New York and London, 262 pp., 1964.

Wyrtki, K., Oceanographic atlas of the International Indian Ocean Expedition, *National Science Foundation*, Washington, D.C., 542 pp., 1971.

NORTH ATLANTIC – INDIAN OCEAN

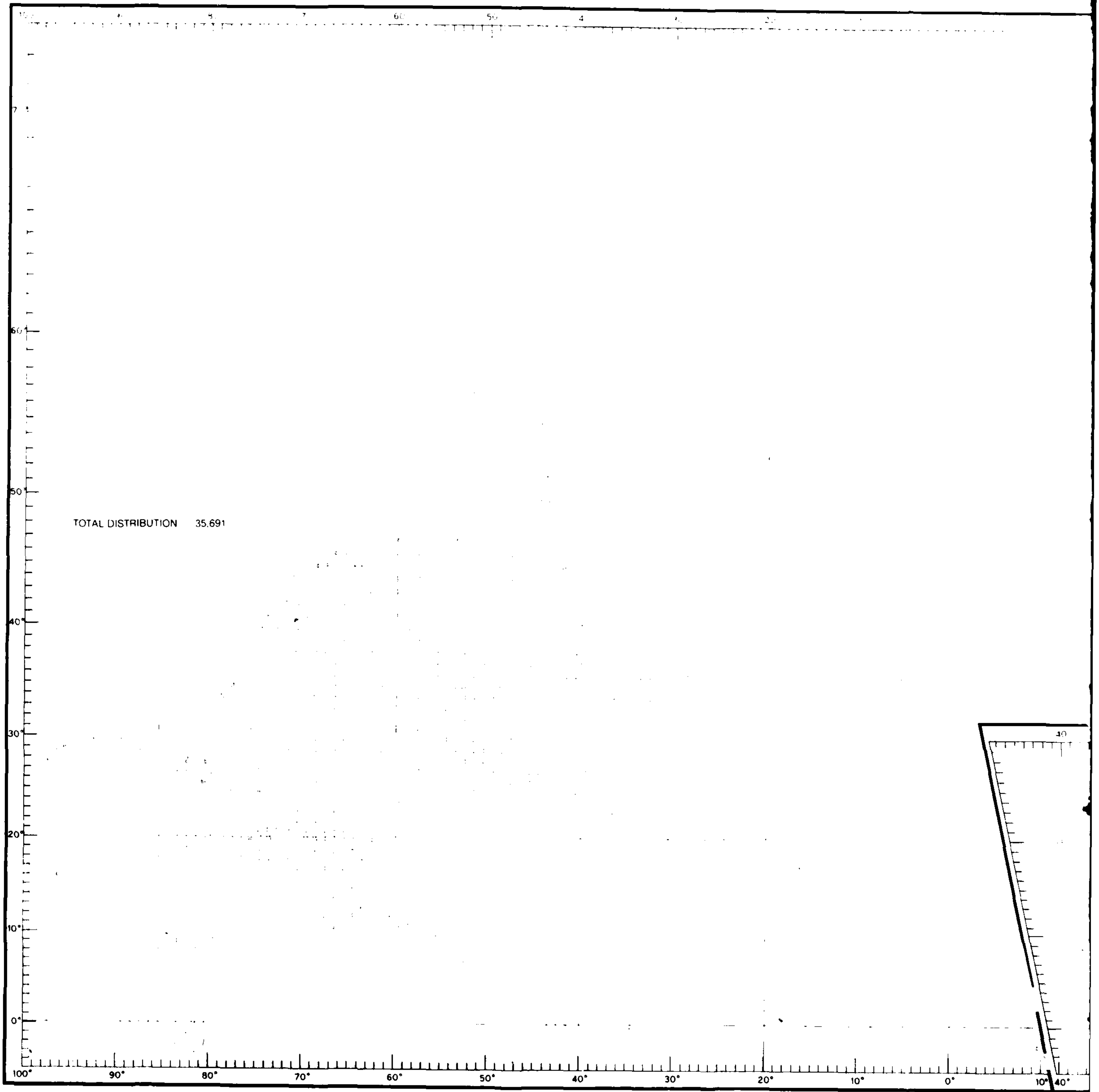
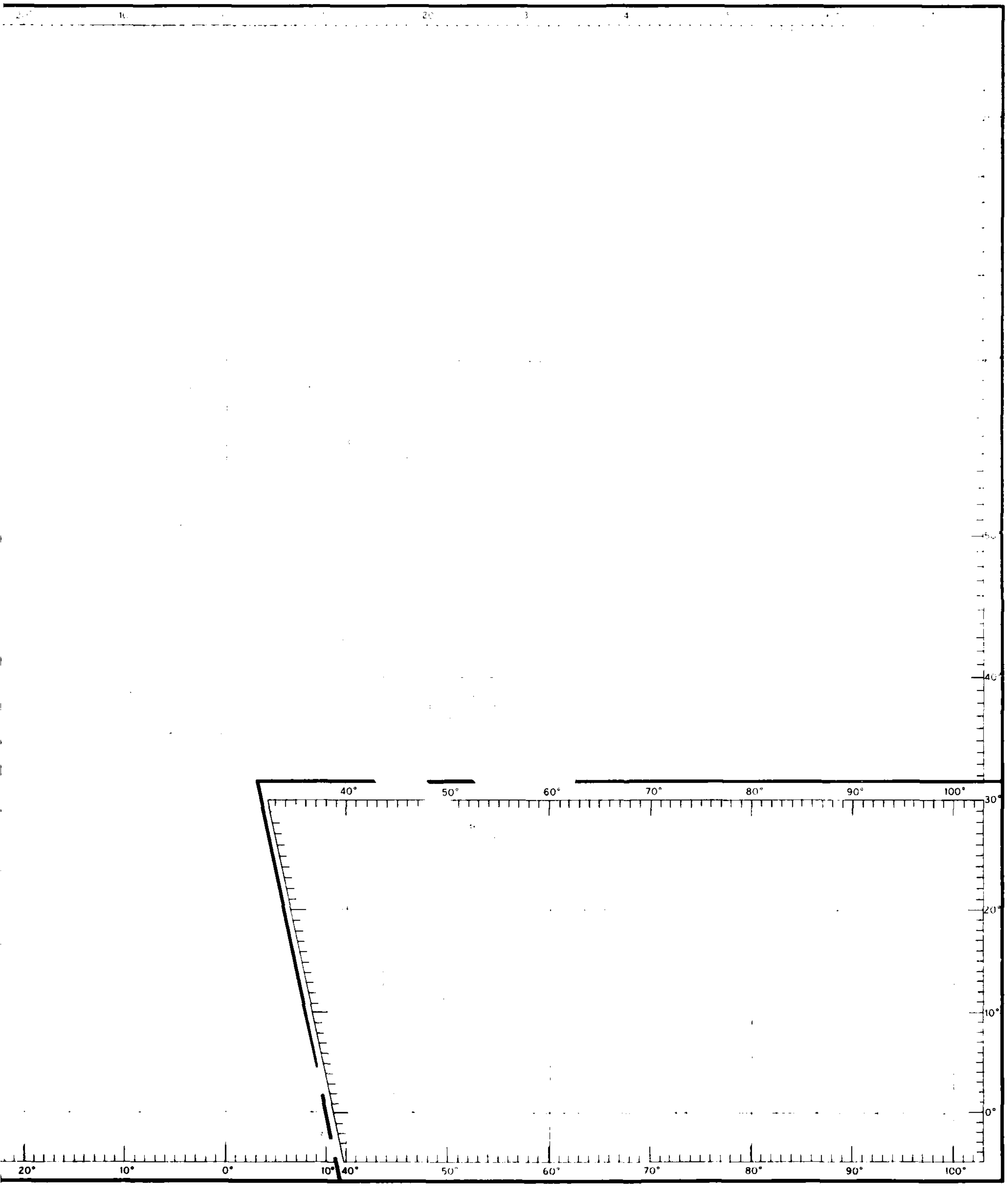


FIGURE 1. JANUARY DATA DISTRIBUTION OF TEMPERATURES AT THE SURFAC



DISTRIBUTION OF TEMPERATURES AT THE SURFACE

1

2

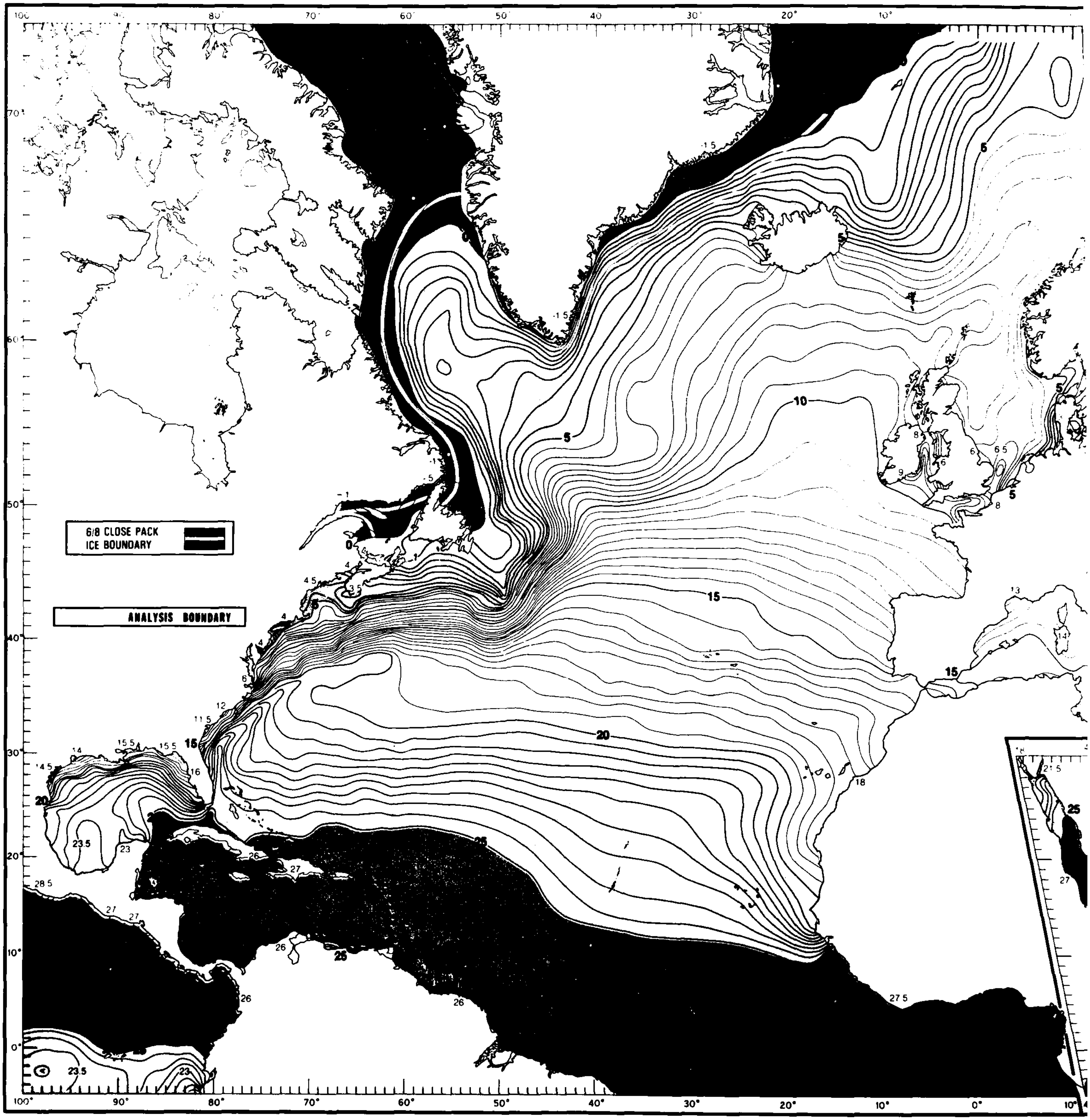
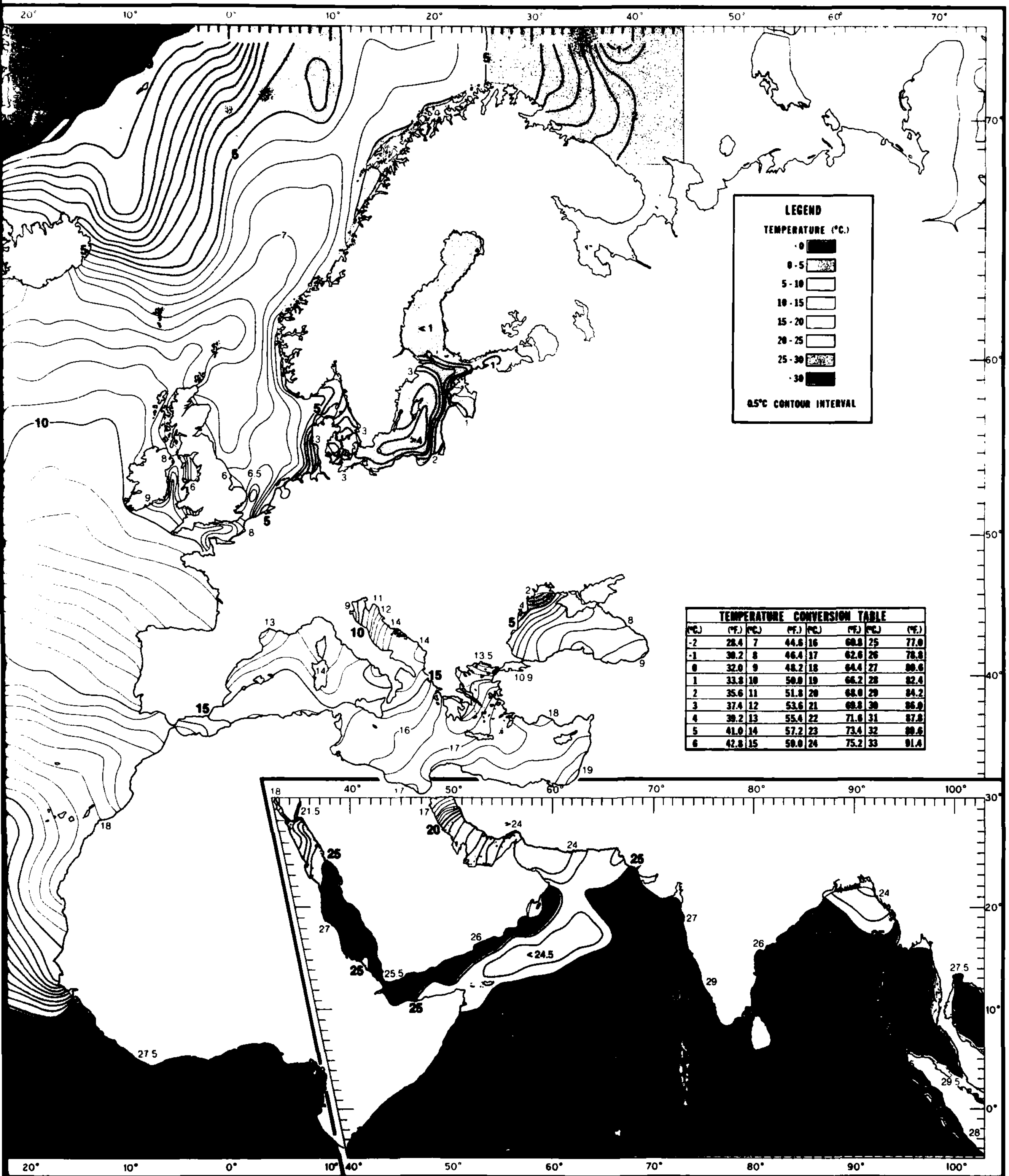


FIGURE 2. JANUARY MEAN TEMPERATURES AT THE SURFACE



TEMPERATURE CONVERSION TABLE							
(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

Y MEAN TEMPERATURES AT THE SURFACE

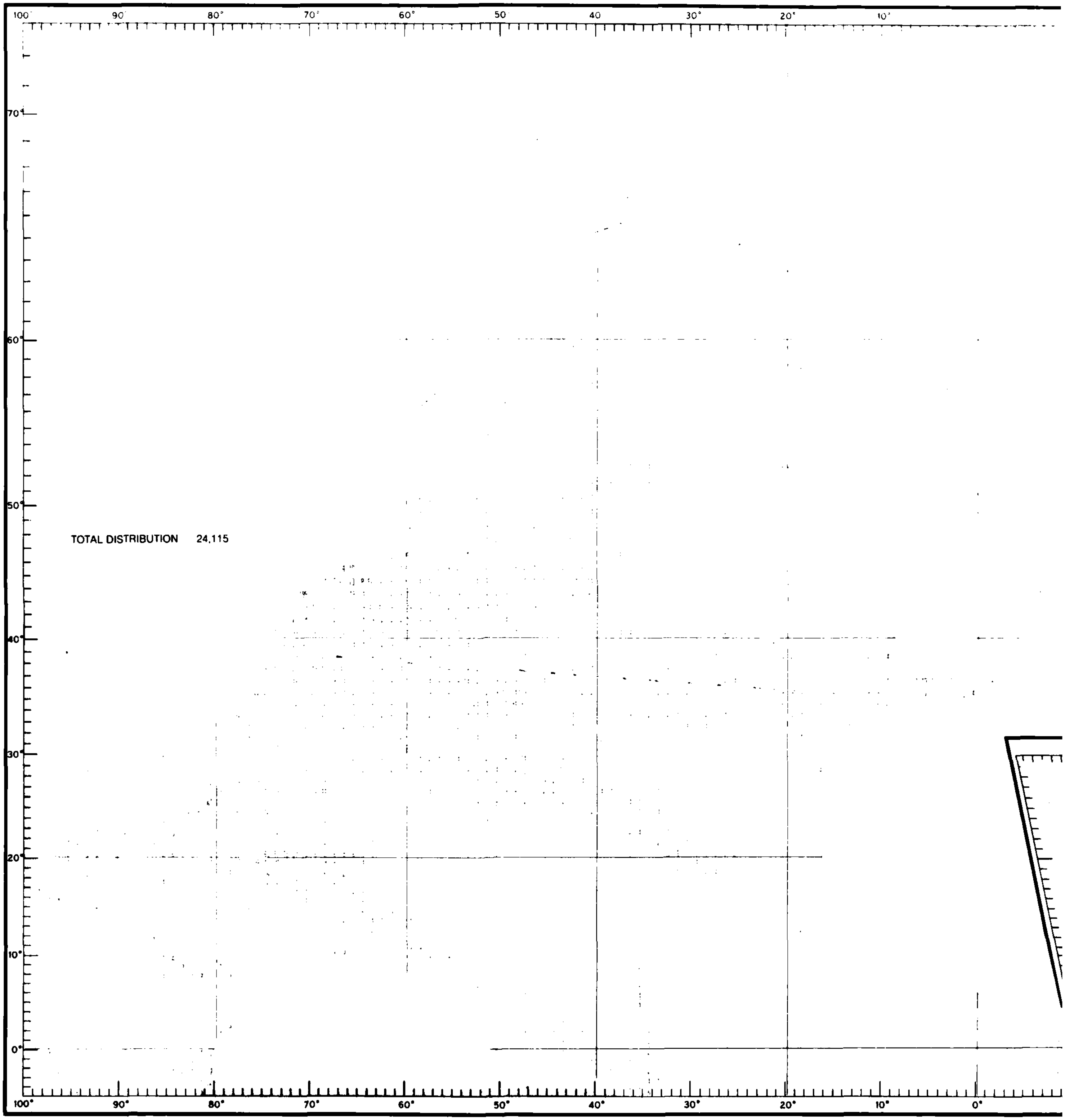
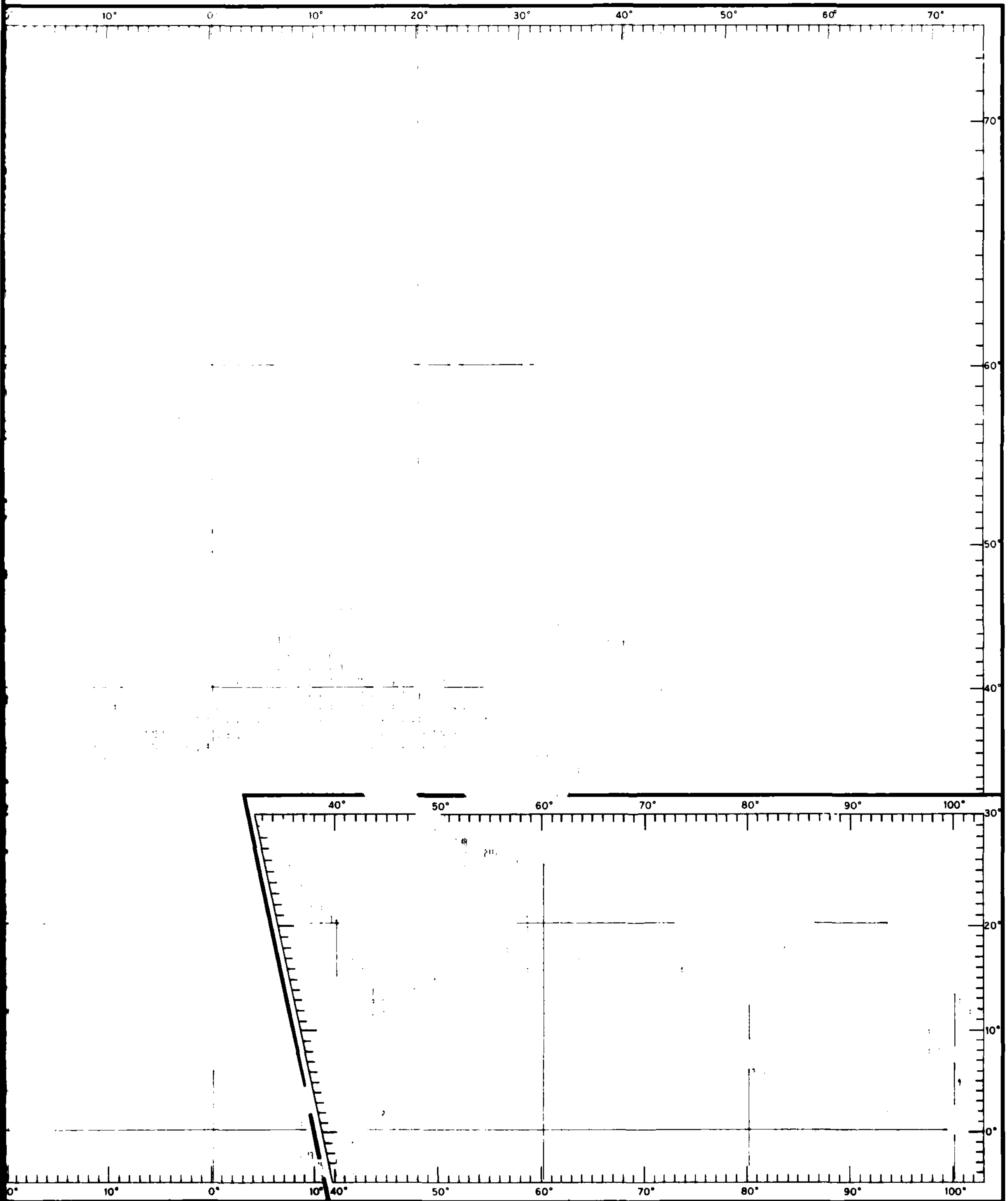


FIGURE 3. JANUARY DATA DISTRIBUTION OF TEMPERATURES AT 100 F

1



TRIBUTION OF TEMPERATURES AT 100 FT (30 M)

2

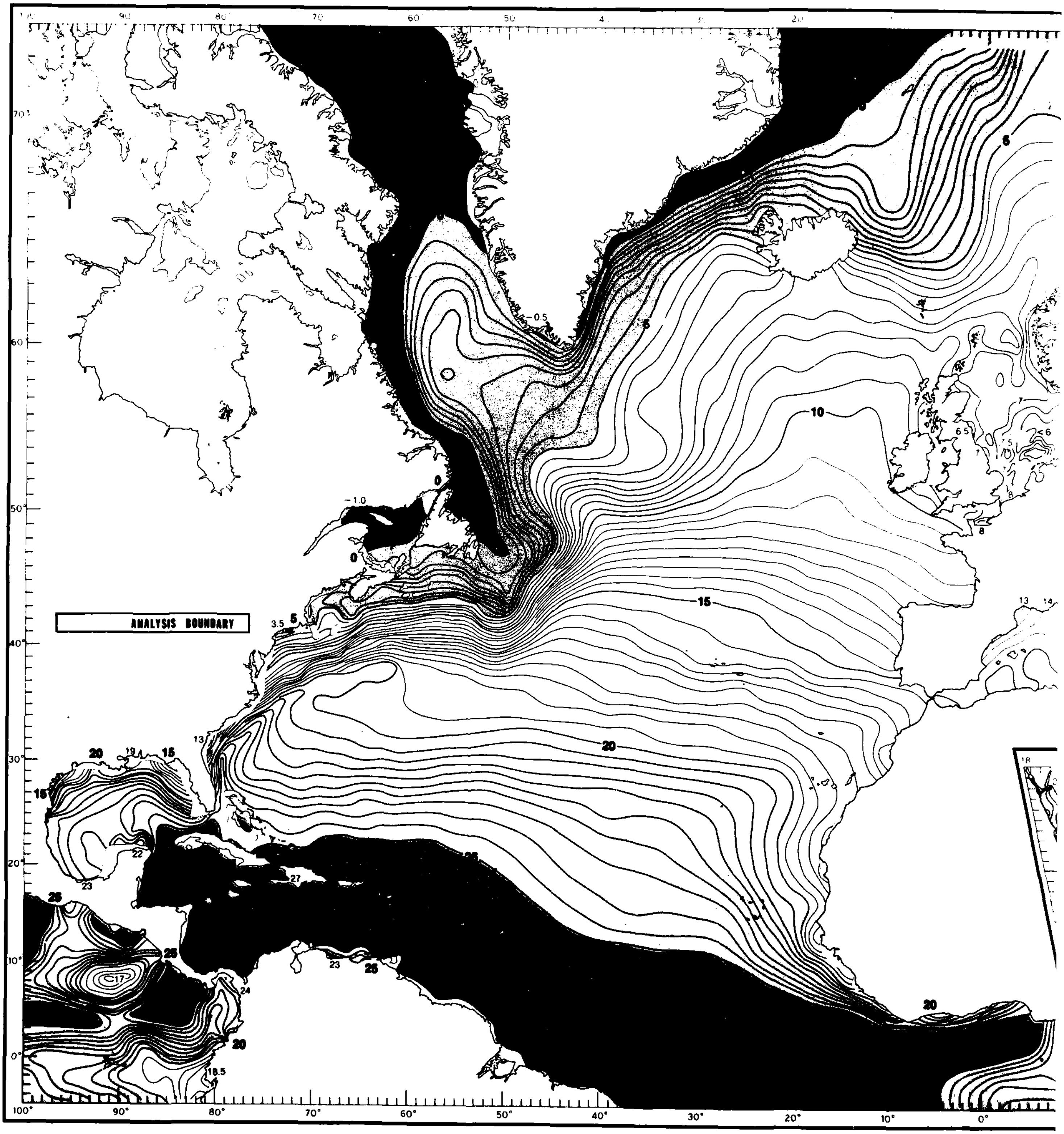
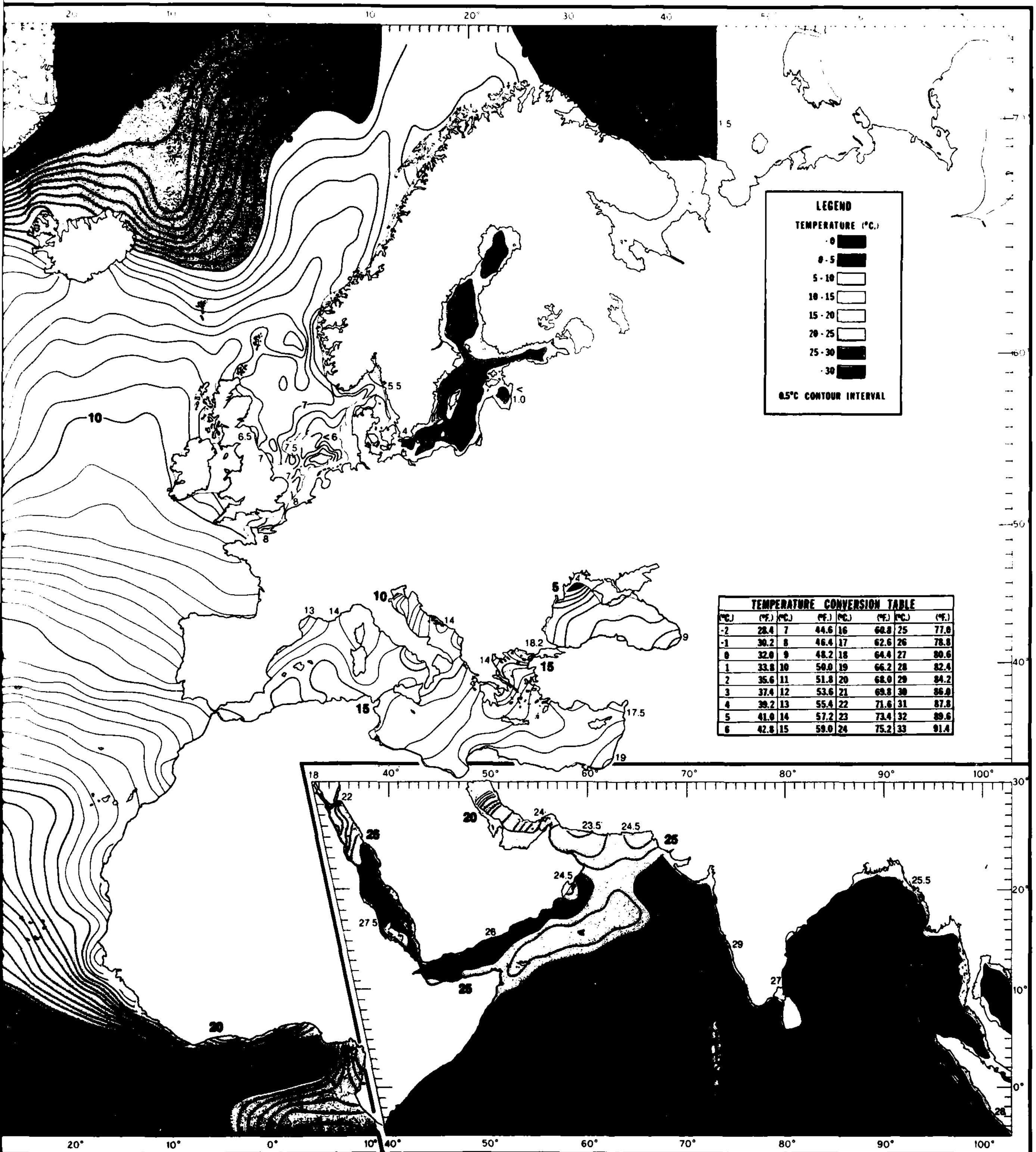


FIGURE 4. JANUARY MEAN TEMPERATURES AT 100 FT (30 M)



TEMPERATURE CONVERSION TABLE							
(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

NUARY MEAN TEMPERATURES AT 100 FT (30 M)

2

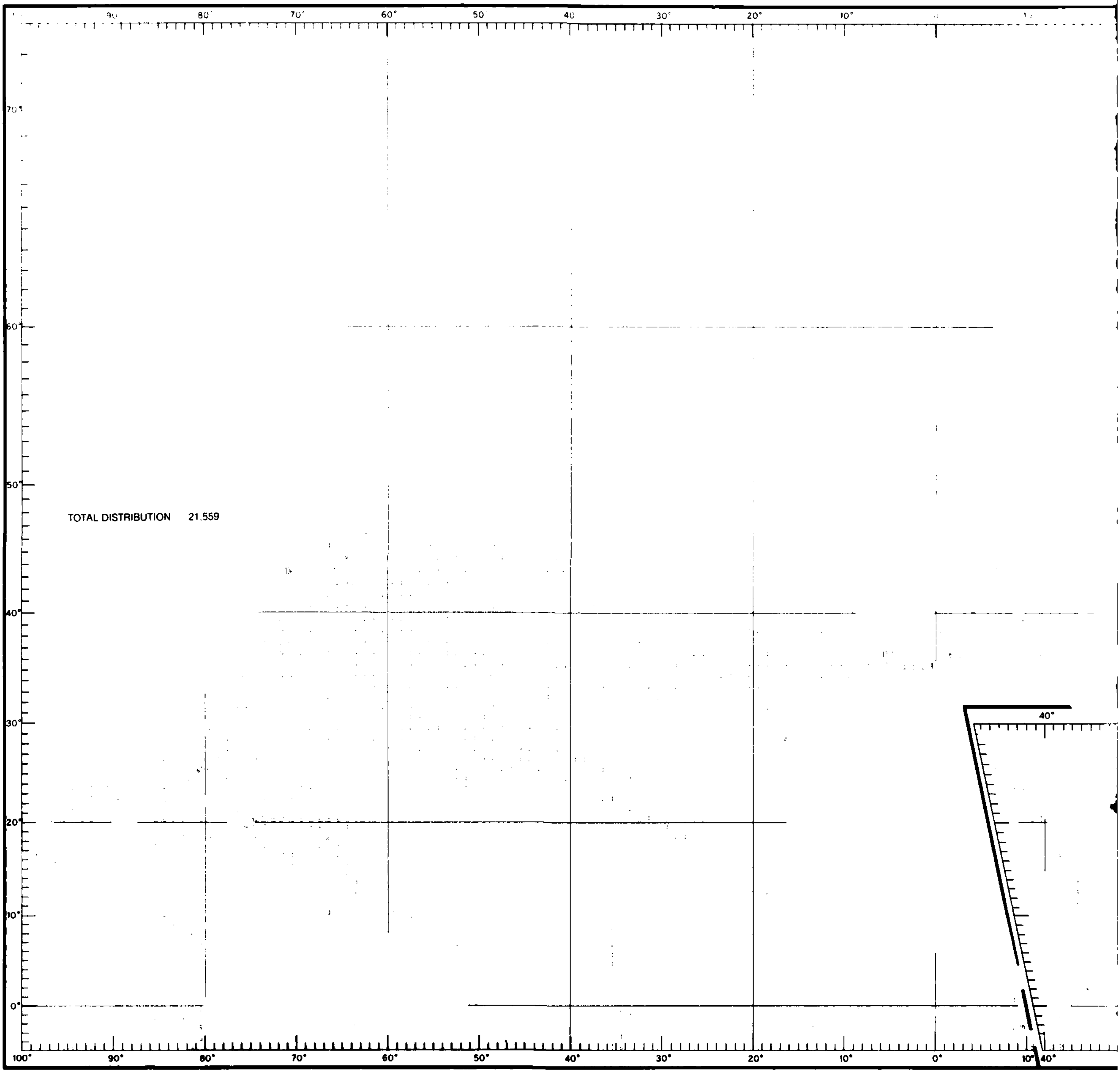
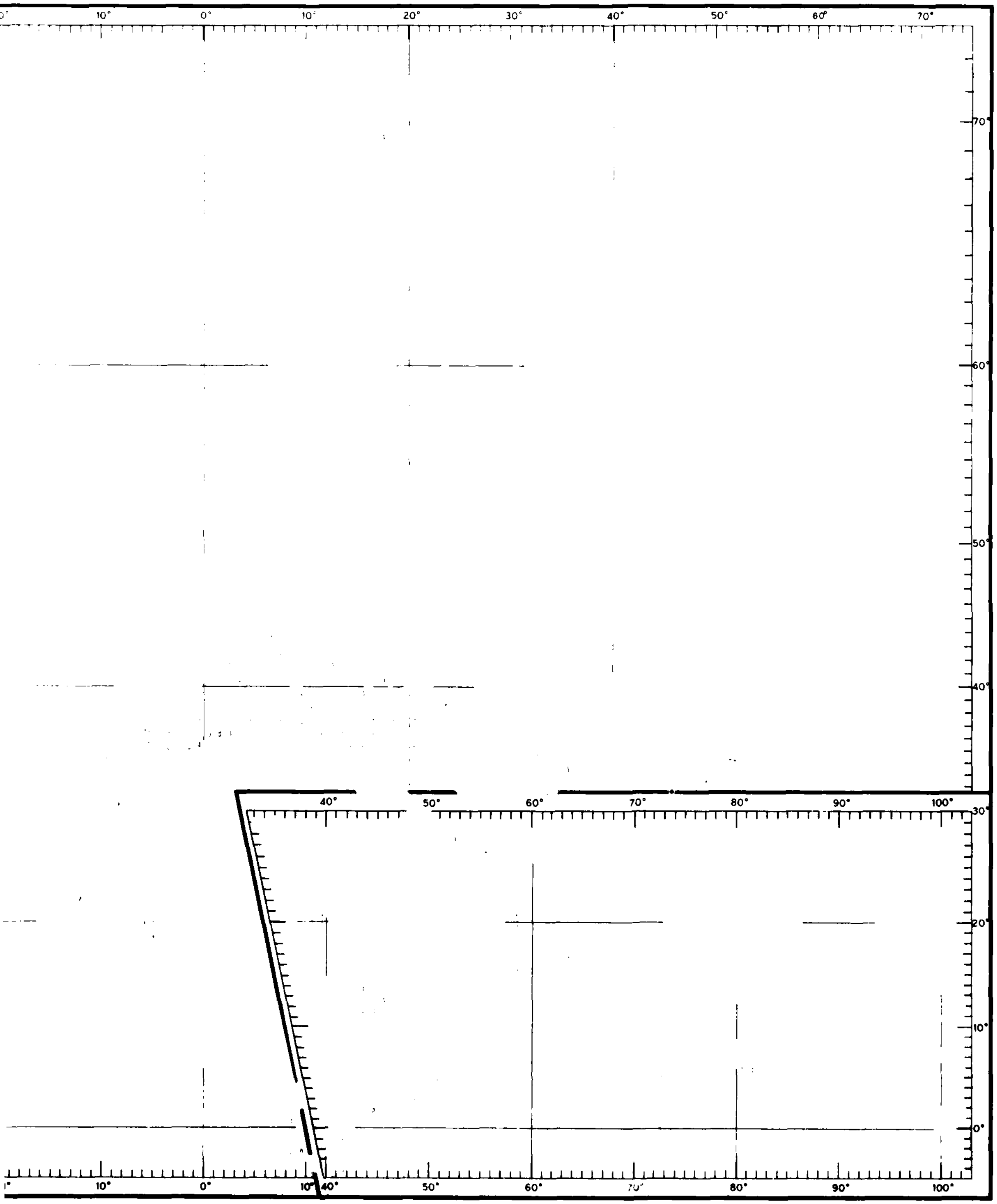


FIGURE 5. JANUARY DATA DISTRIBUTION OF TEMPERATURES AT 200 FT (60 M)



RIBUTION OF TEMPERATURES AT 200 FT (60 M)

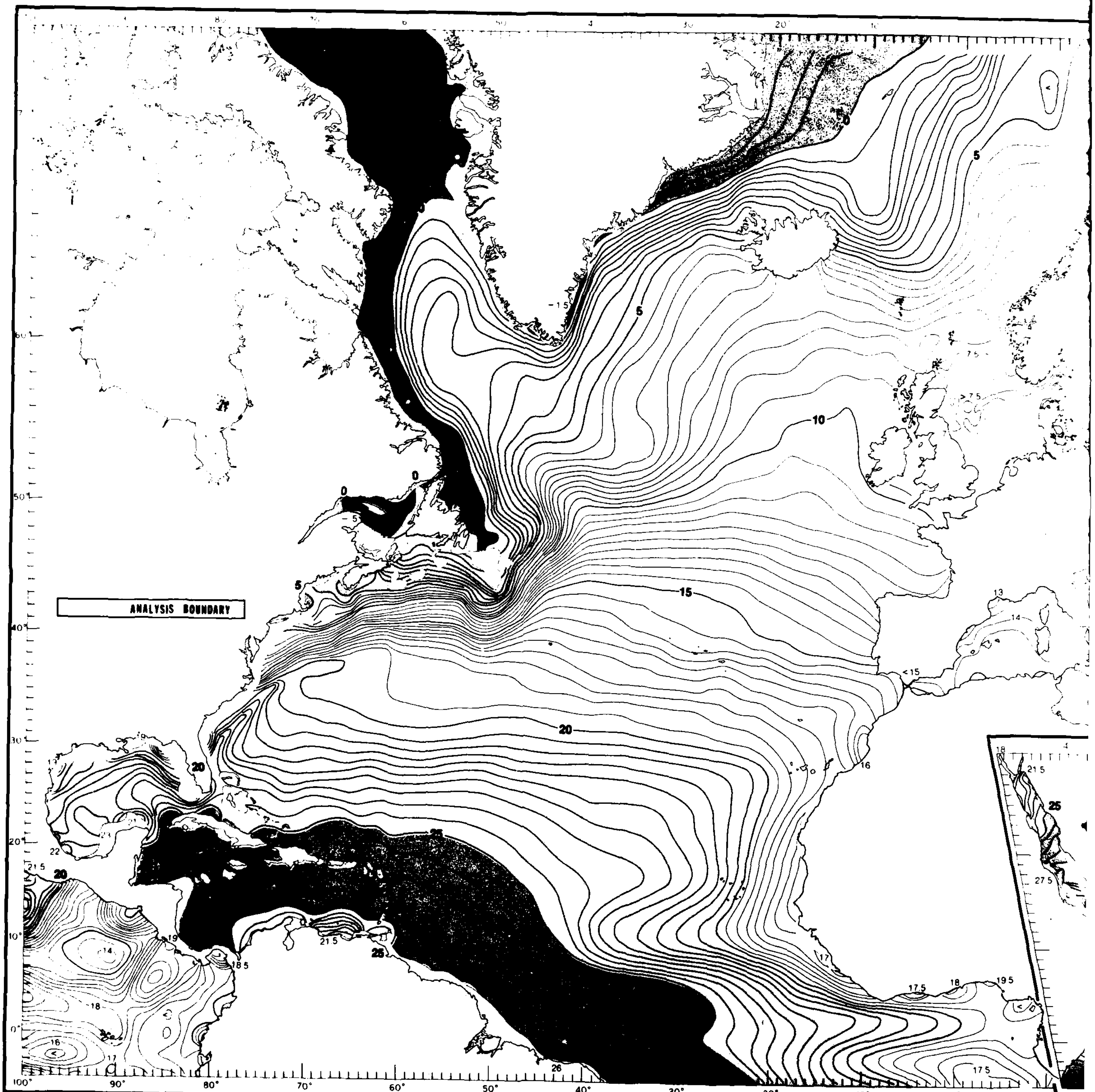
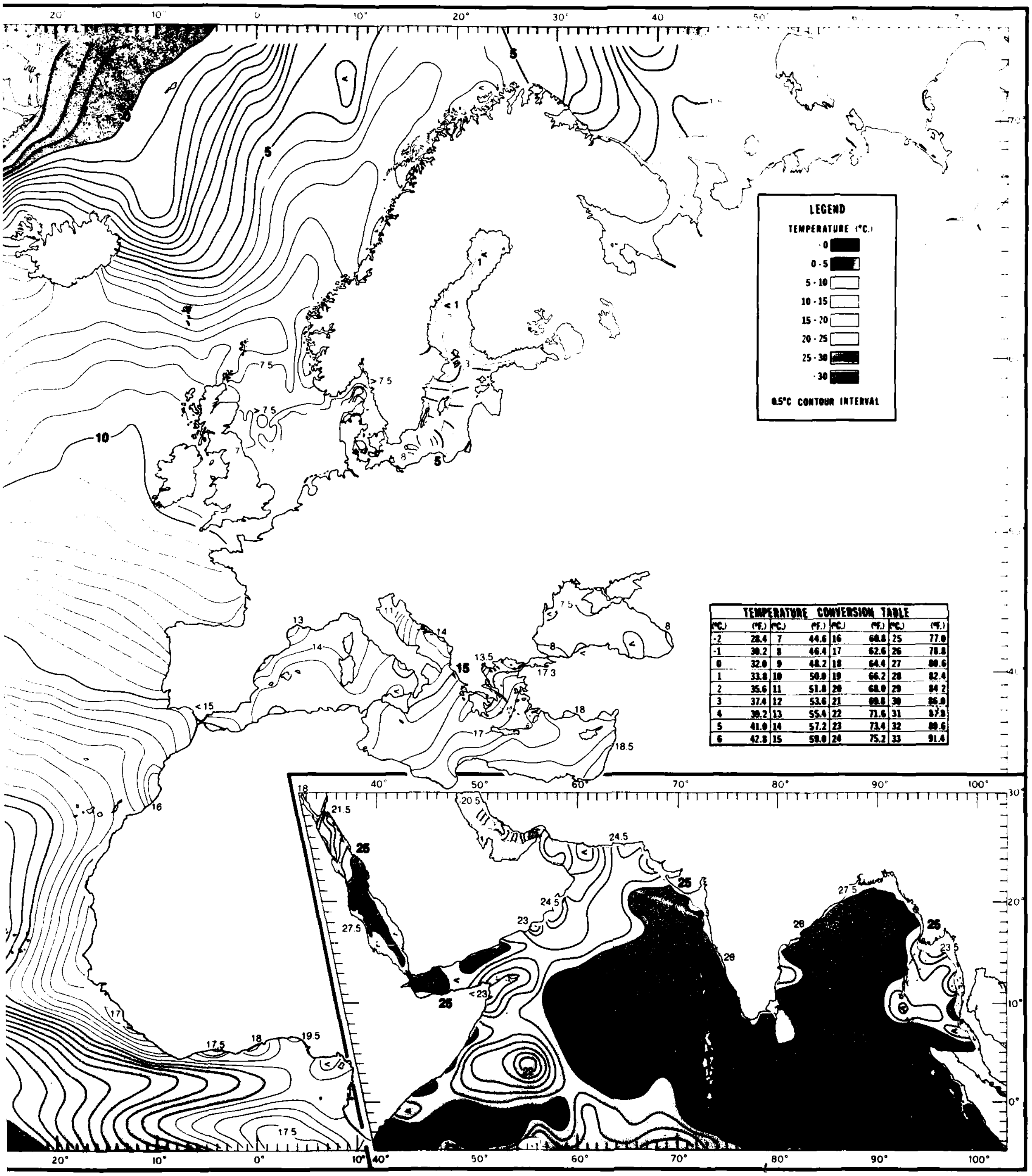


FIGURE 6. JANUARY MEAN TEMPERATURES AT 200 FT (60 M)

7



TEMPERATURE CONVERSION TABLE							
(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

RY MEAN TEMPERATURES AT 200 FT (60 M)

2

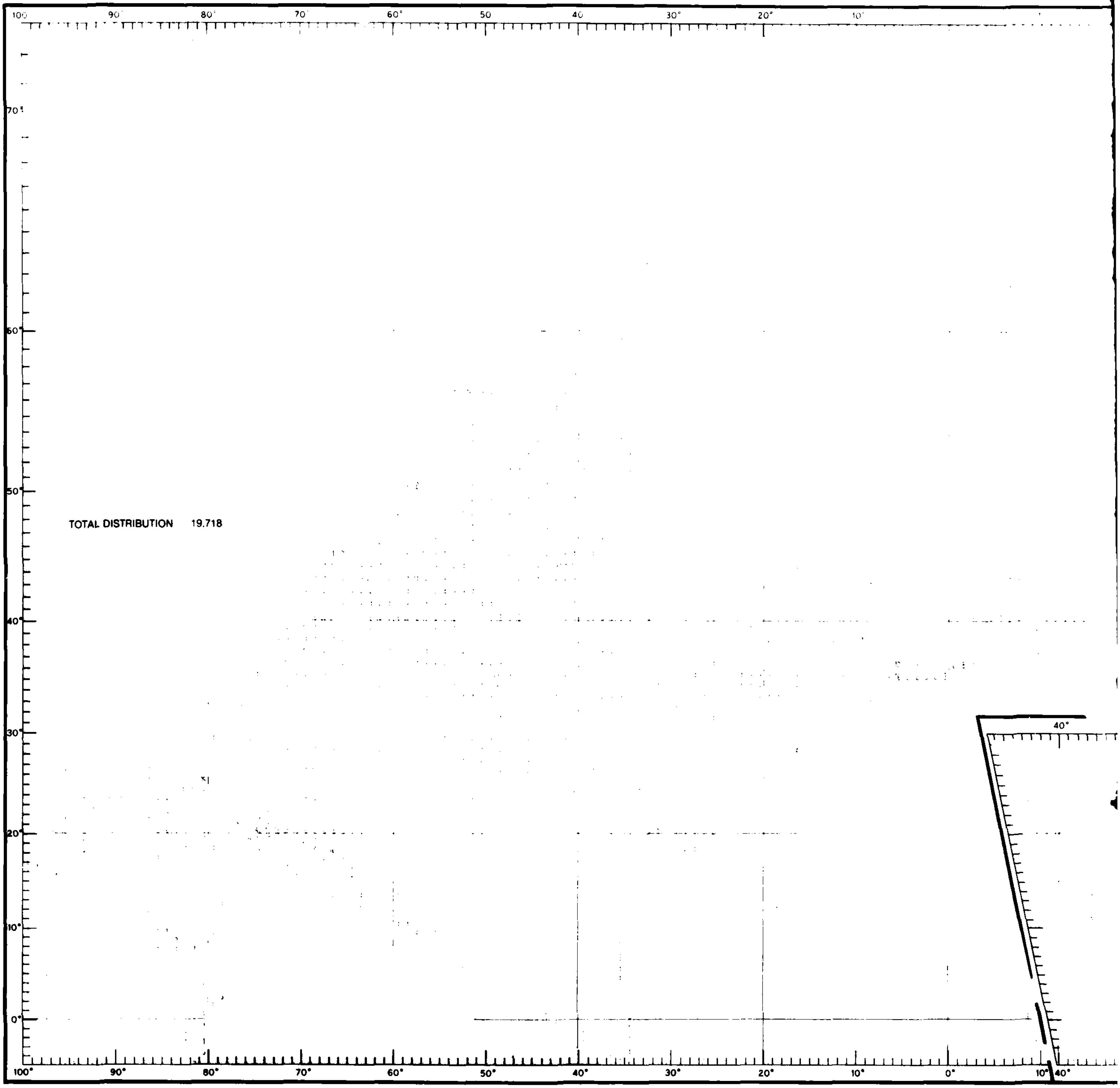
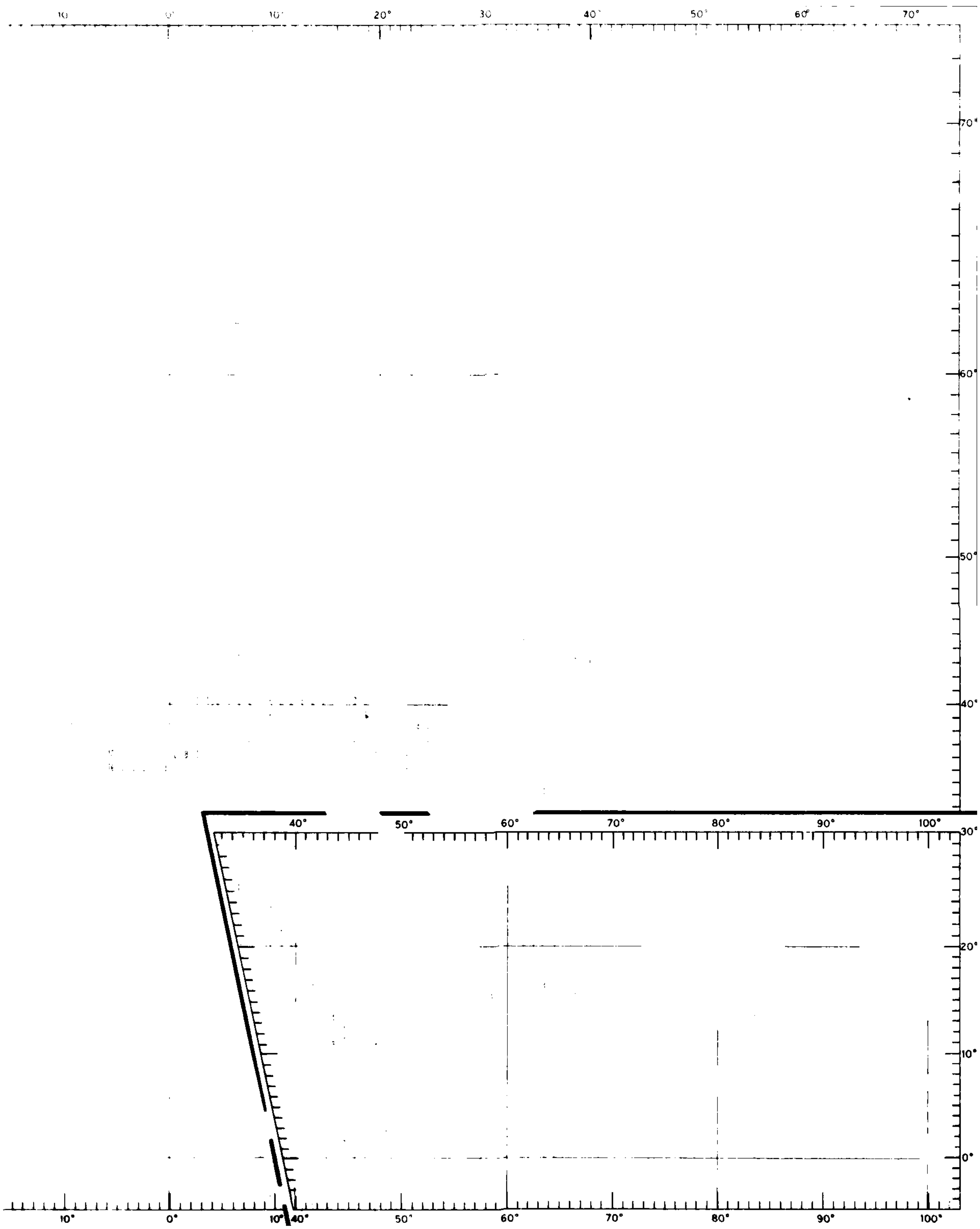


FIGURE 7. JANUARY DATA DISTRIBUTION OF TEMPERATURES AT 300 FT (90 M)



20°
40°
50°
60°
70°
60°
50°
40°
40°
50°
60°
70°
80°
90°
100°
30°
20°
10°
0°
10°
0°
10°
40°
50°
60°
70°
80°
90°
100°

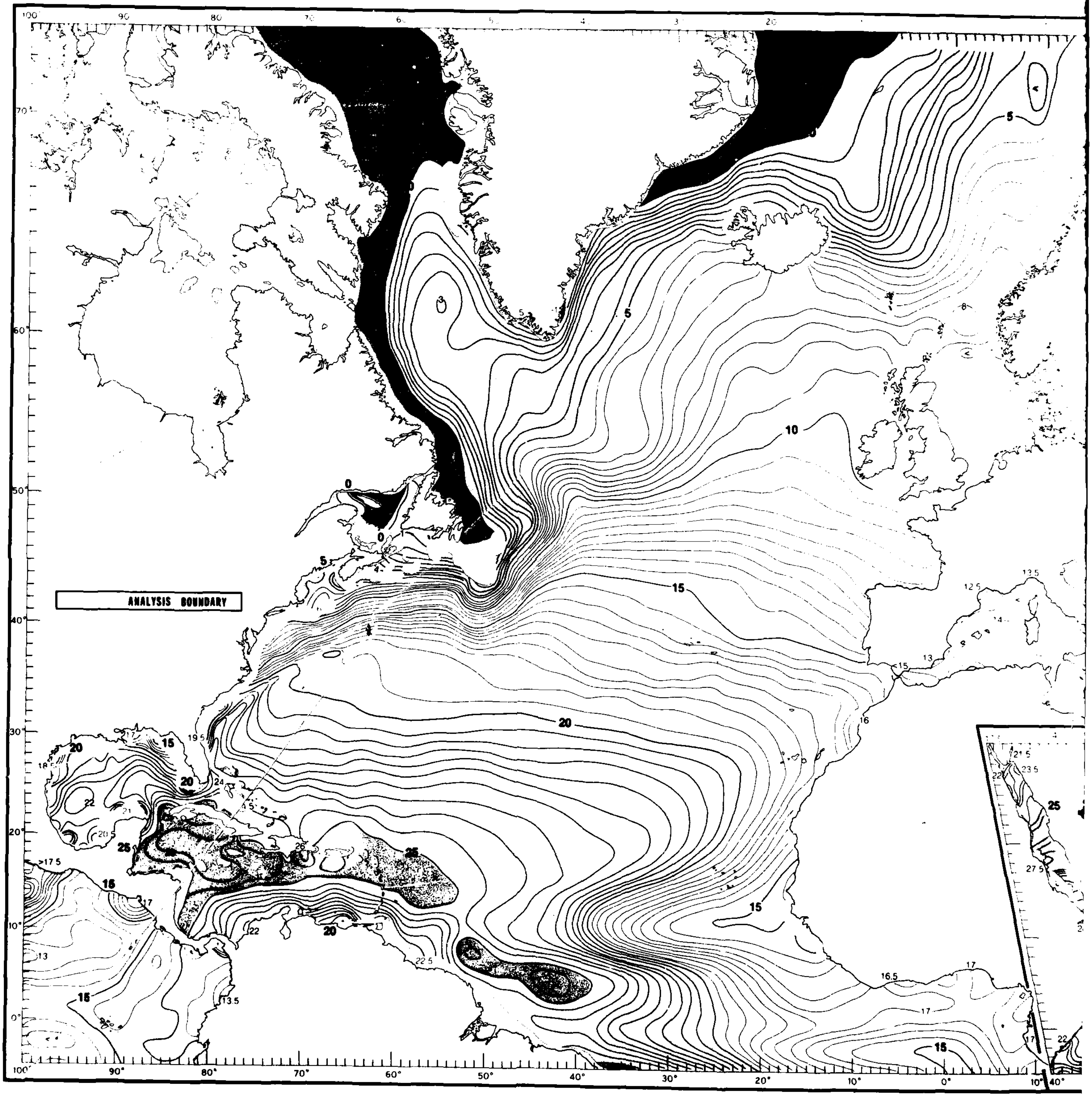
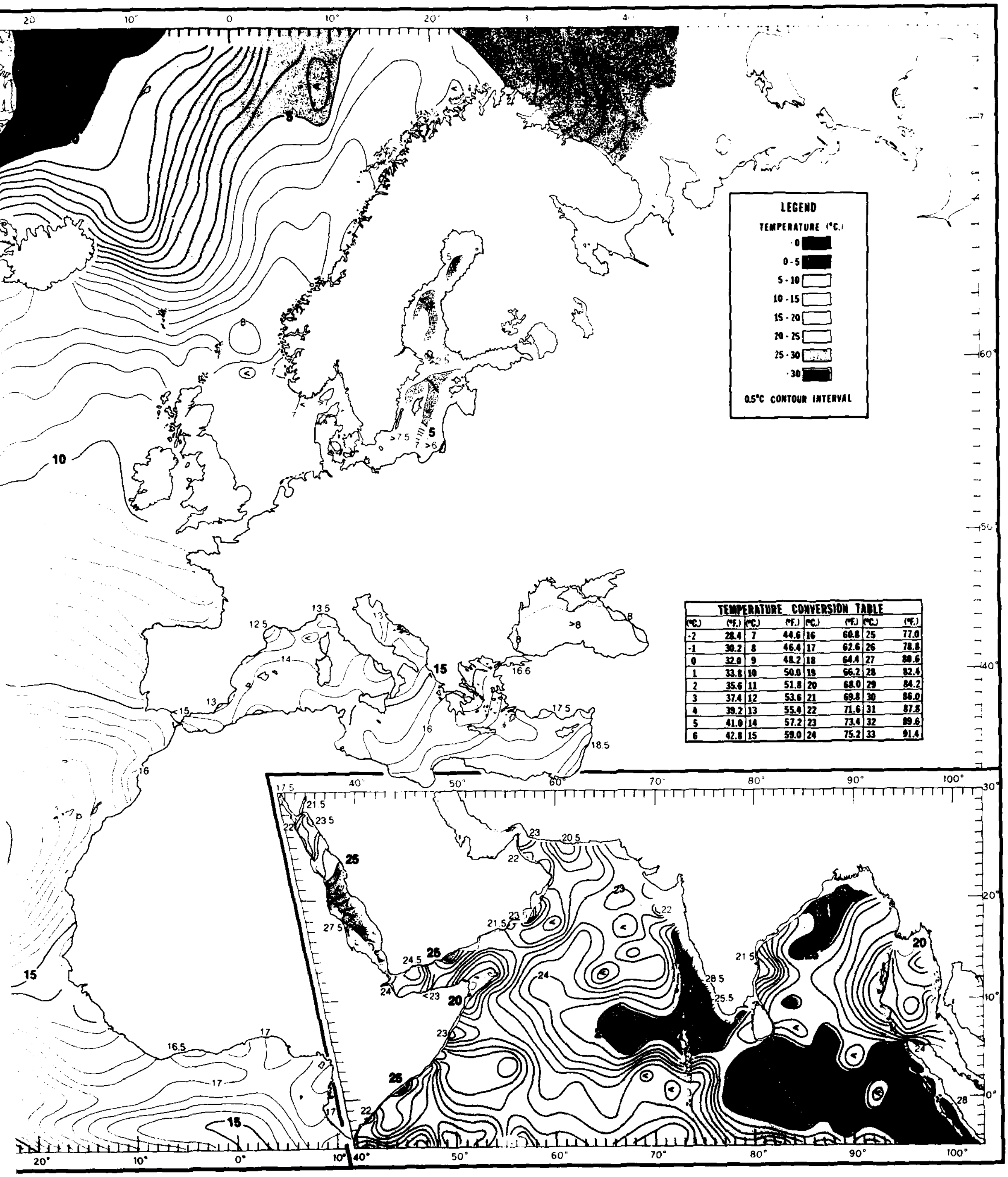


FIGURE 8. JANUARY MEAN TEMPERATURES AT 300 FT (90 M)



TEMPERATURE CONVERSION TABLE							
(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

Y MEAN TEMPERATURES AT 300 FT (90 M)

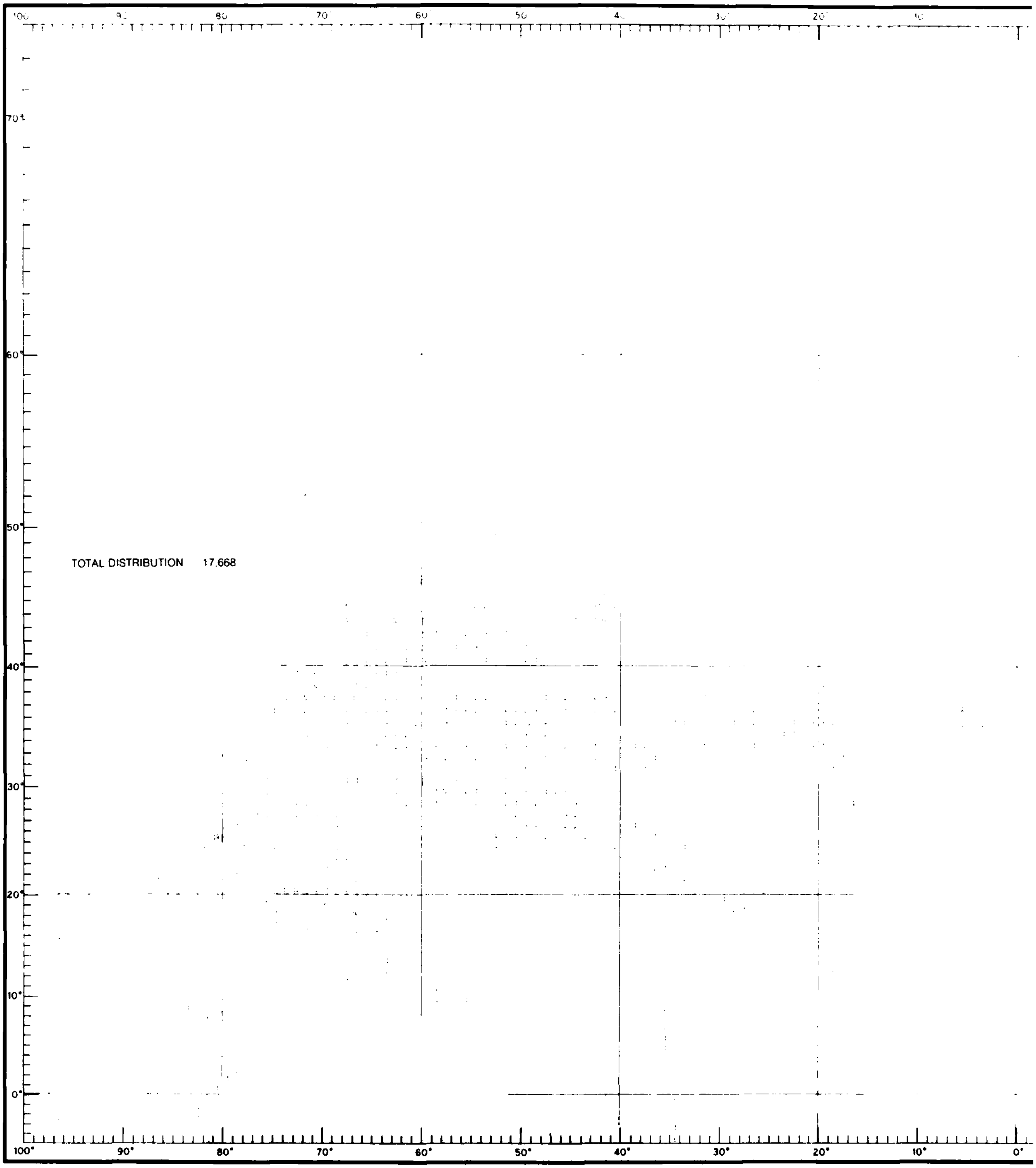
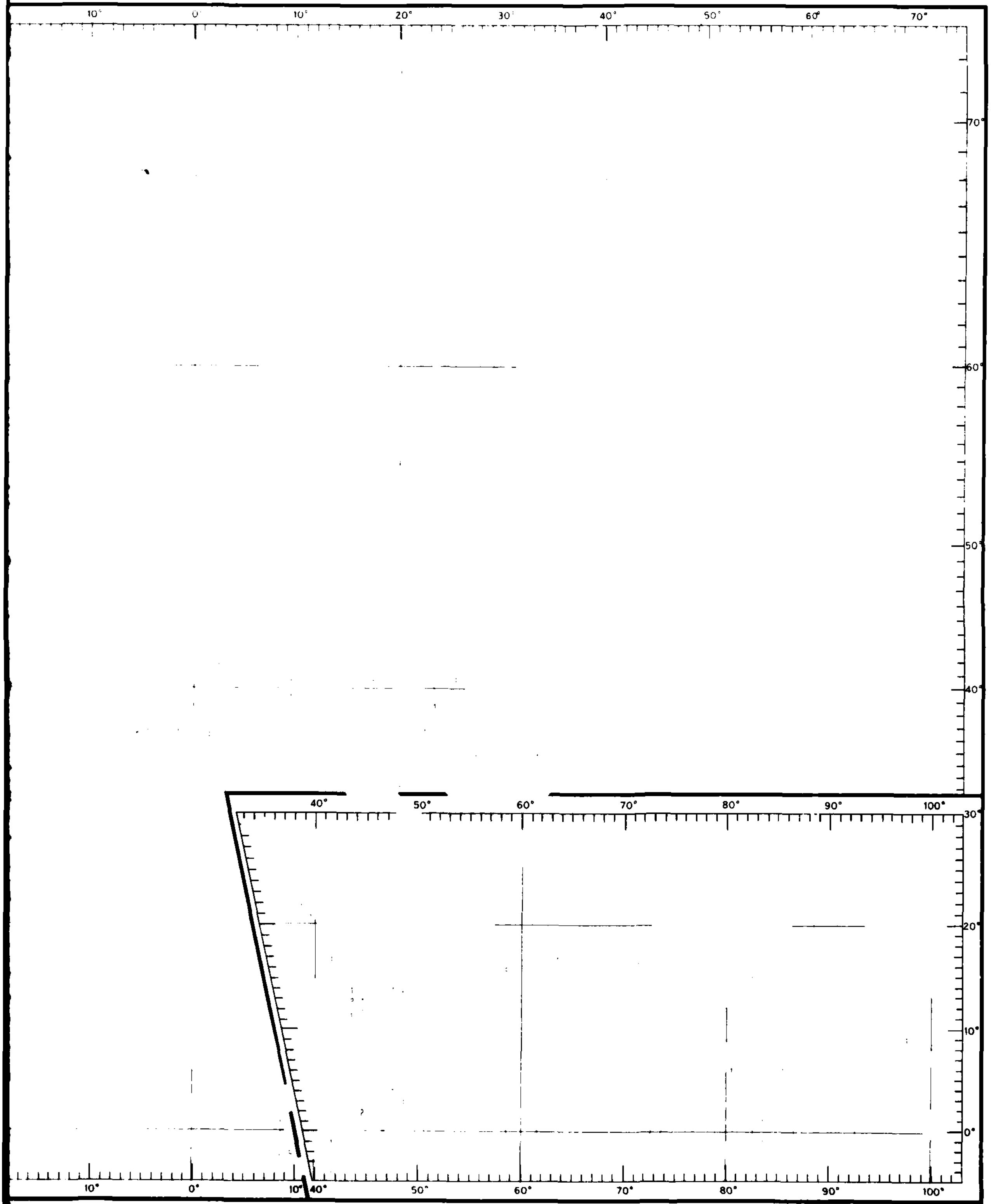


FIGURE 9. JANUARY DATA DISTRIBUTION OF TEMPERATURES

1



UTION OF TEMPERATURES AT 400 FT (120 M)

2

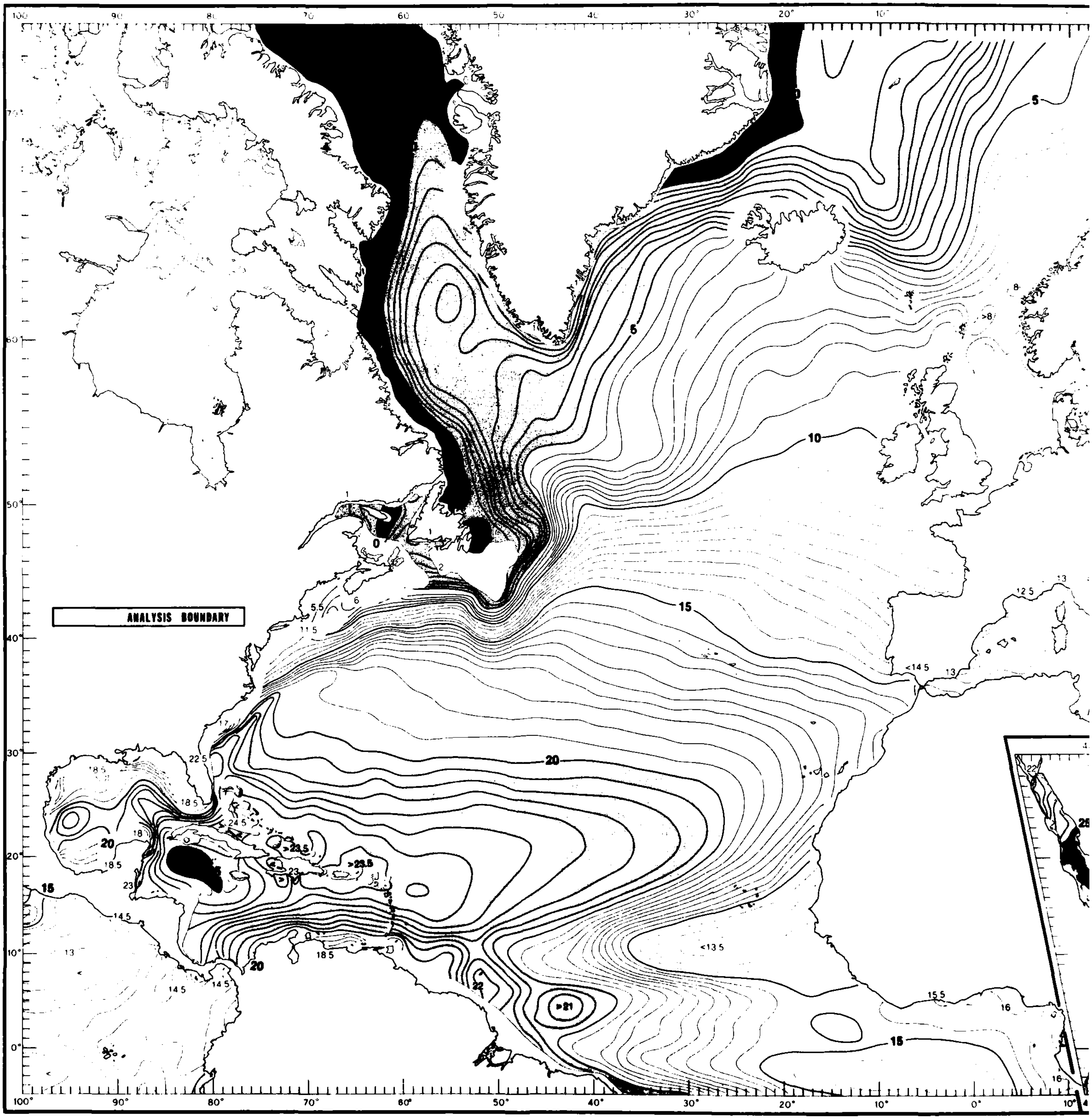
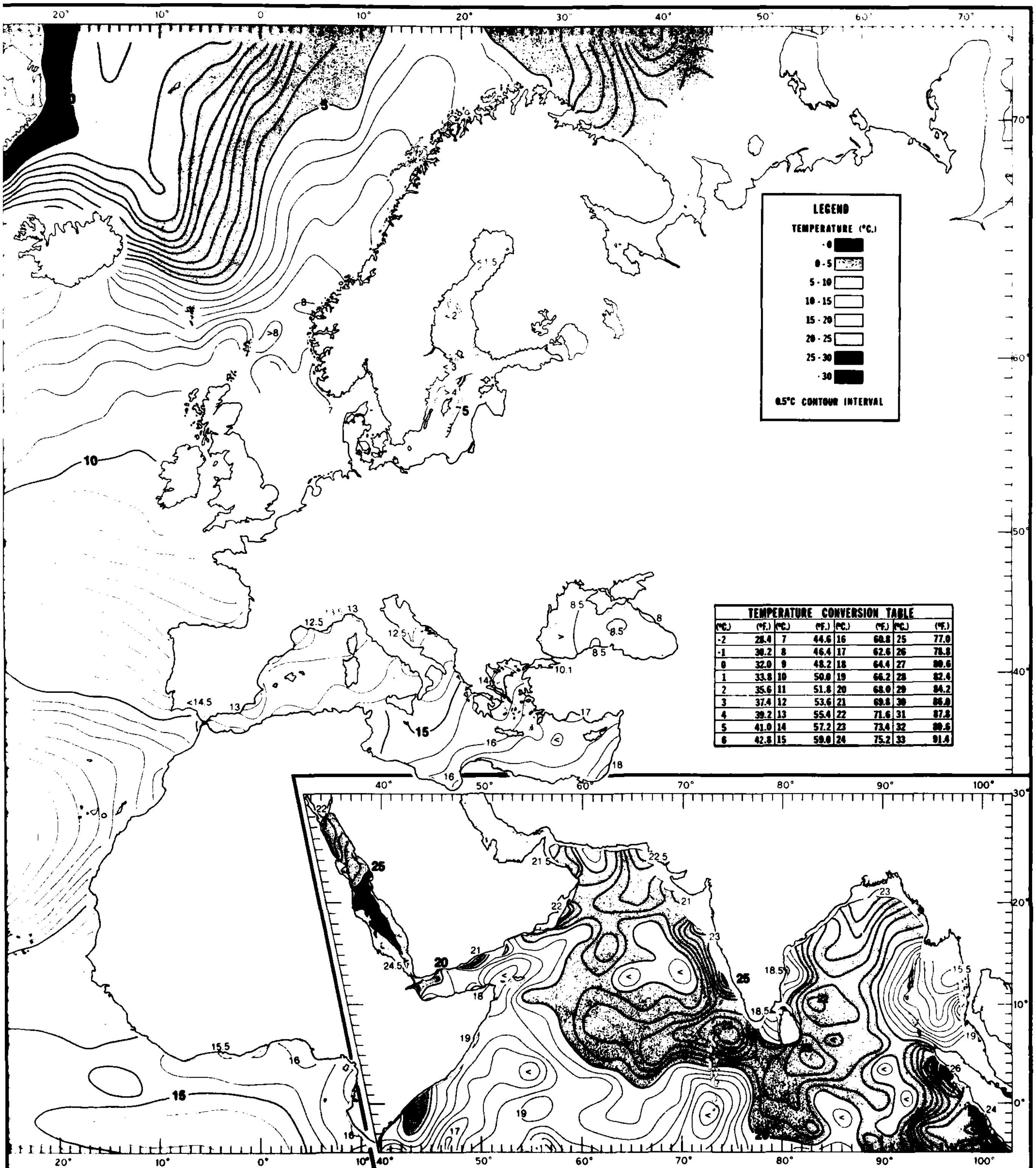


FIGURE 10. JANUARY MEAN TEMPERATURES AT 400 FT (120 M)

7



TEMPERATURE CONVERSION TABLE

(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

UARY MEAN TEMPERATURES AT 400 FT (120 M)

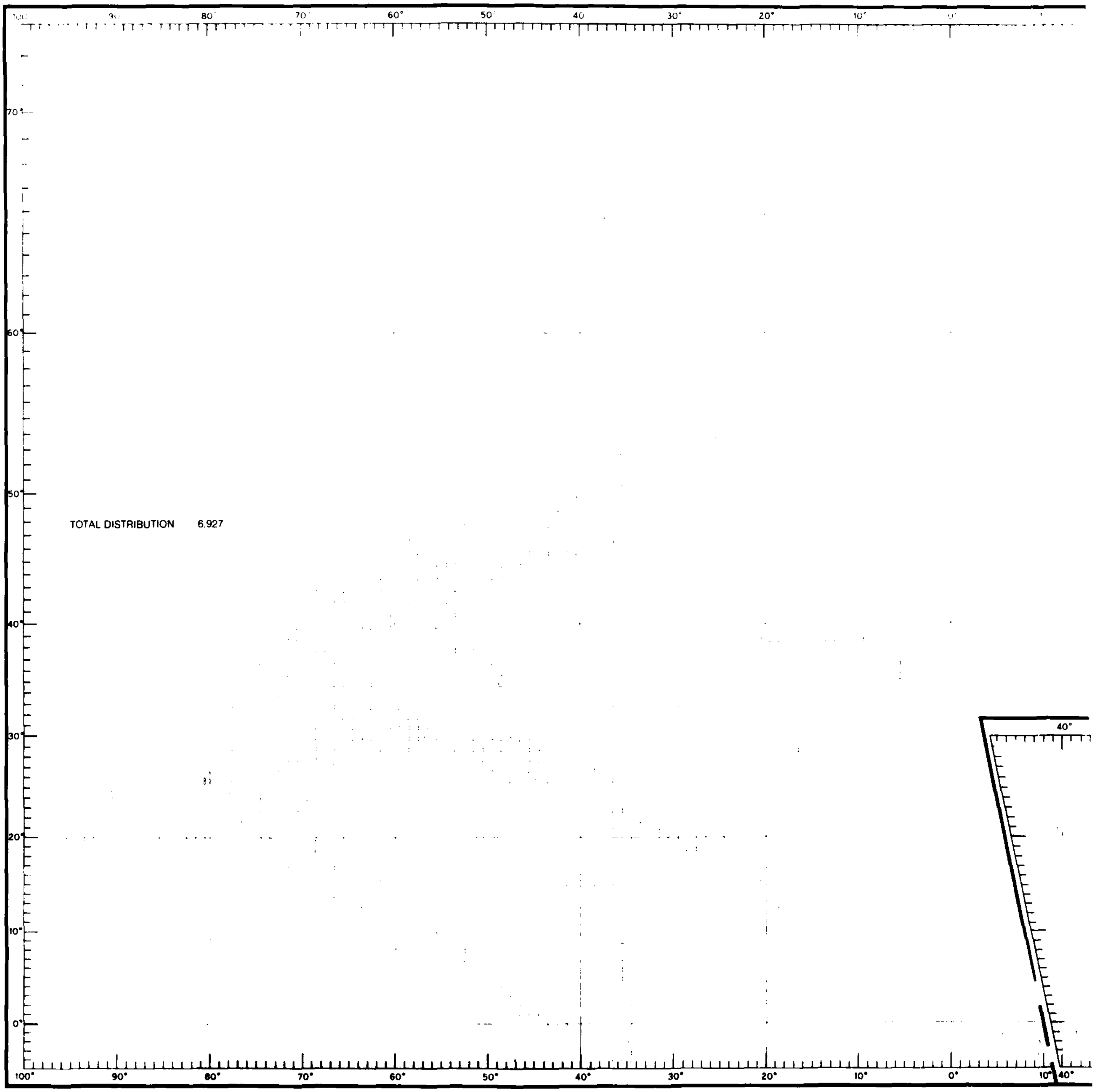
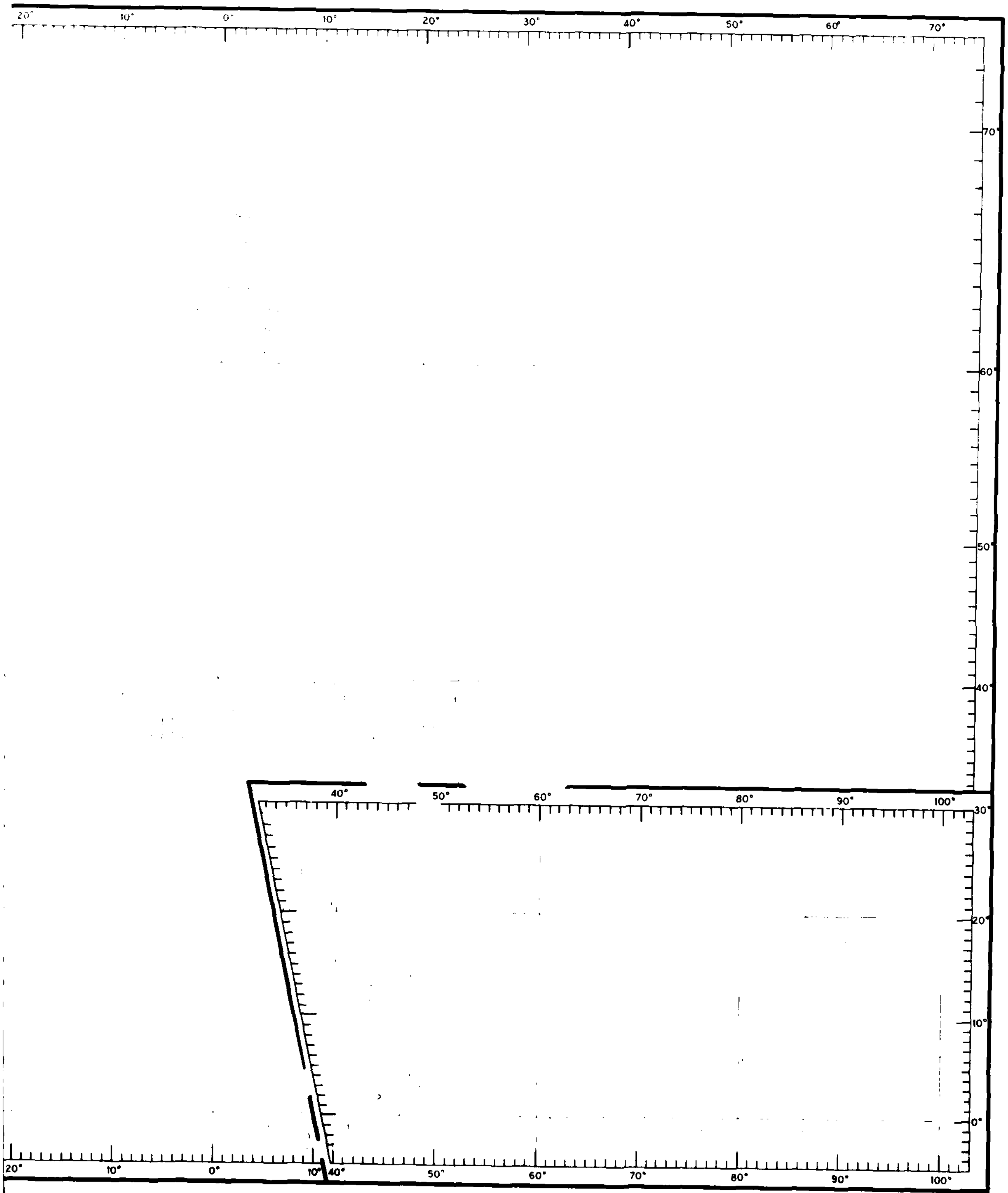


FIGURE 11. JANUARY DATA DISTRIBUTION OF TEMPERATURES AT 492 FT (150 M



TRIBUTION OF TEMPERATURES AT 492 FT (150 M)

2

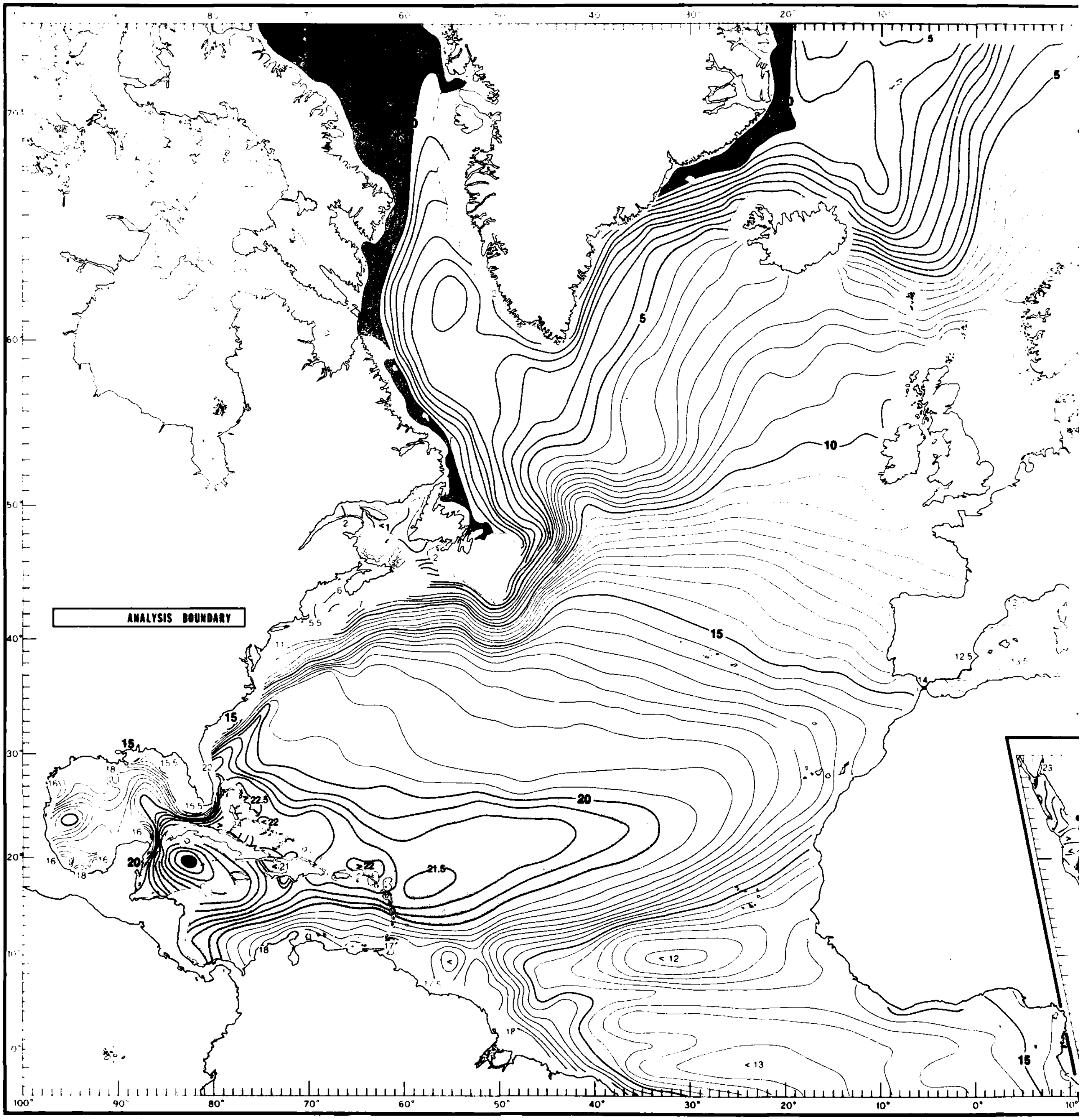
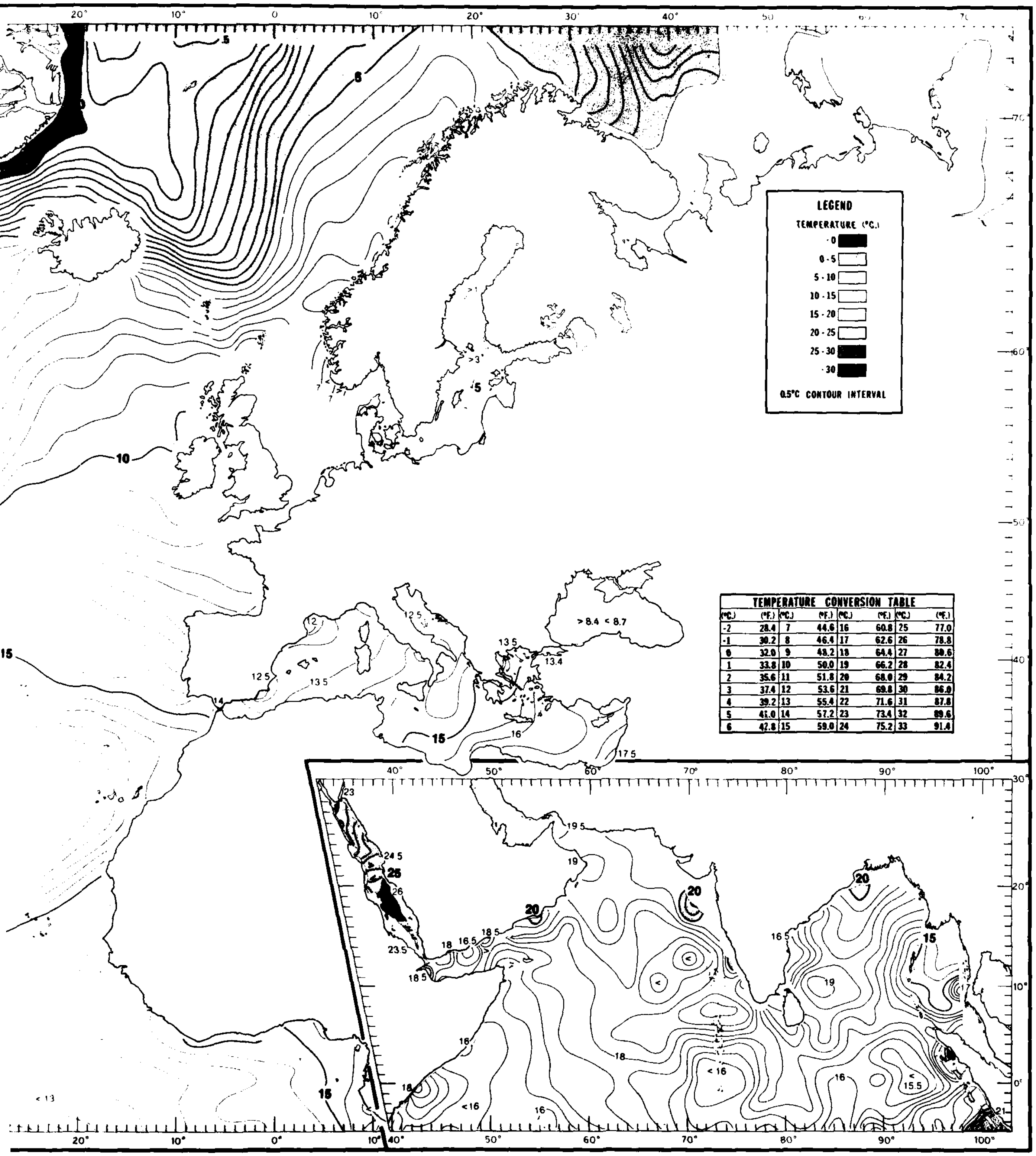


FIGURE 12. JANUARY MEAN TEMPERATURES AT 492 FT (150 M)

1



TEMPERATURE CONVERSION TABLE

(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

NUARY MEAN TEMPERATURES AT 492 FT (150 M)

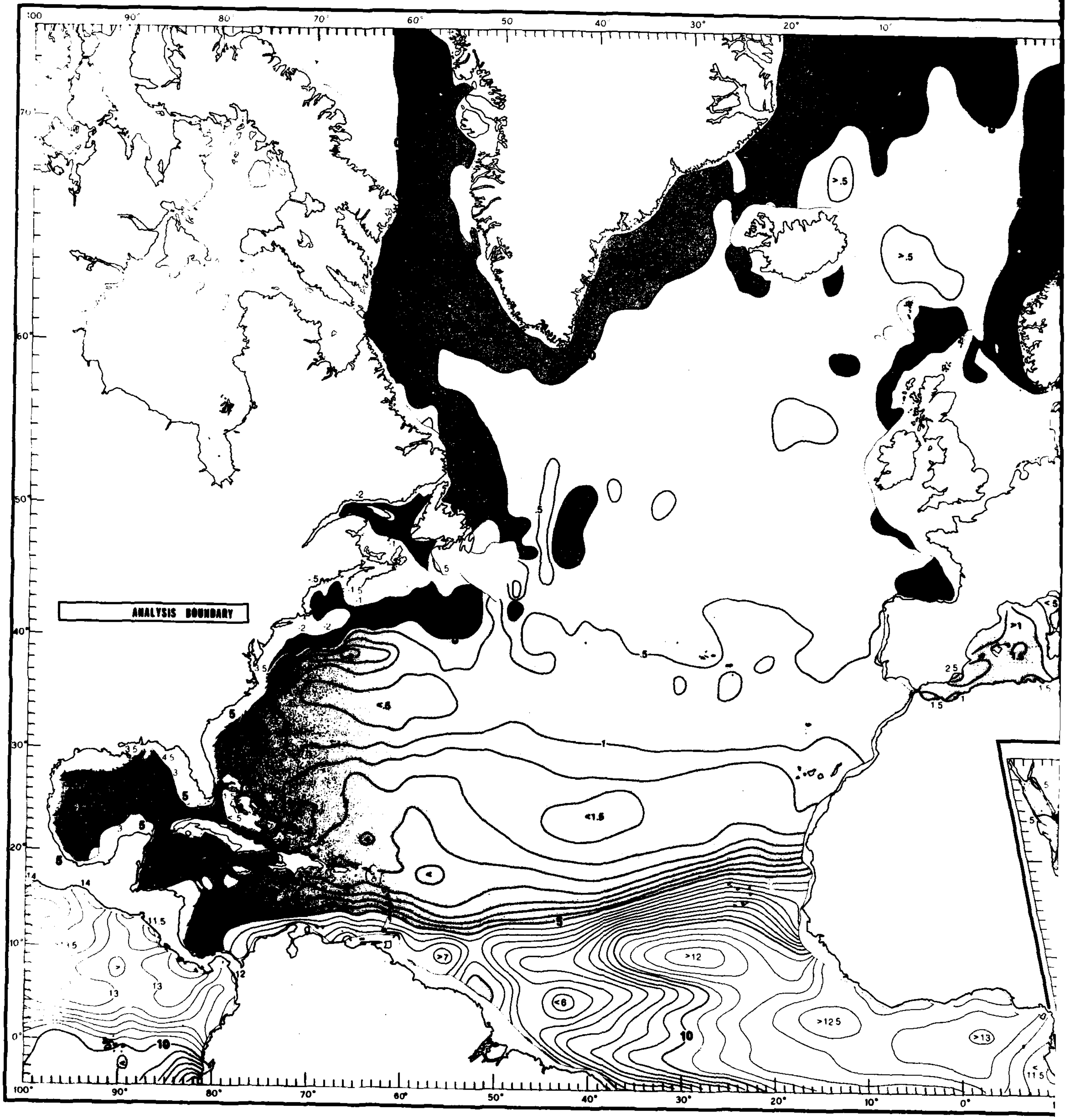
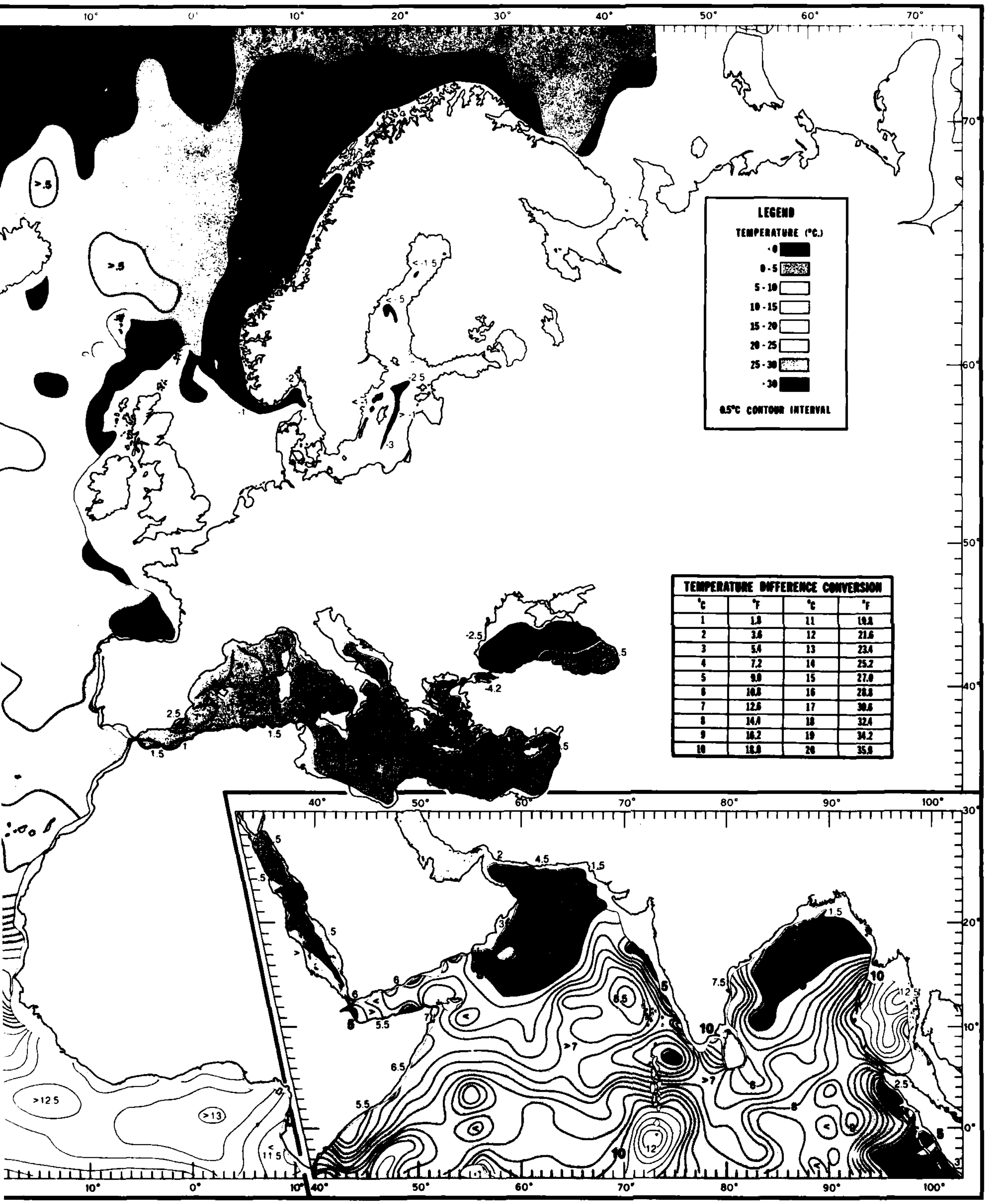


FIGURE 13. JANUARY TEMPERATURE DIFFERENCE BETWEEN THE SURFACE AND

1



TEMPERATURE DIFFERENCE CONVERSION			
°C	°F	°C	°F
1	1.8	11	19.8
2	3.6	12	21.6
3	5.4	13	23.4
4	7.2	14	25.2
5	9.0	15	27.0
6	10.8	16	28.8
7	12.6	17	30.6
8	14.4	18	32.4
9	16.2	19	34.2
10	18.0	20	35.8

ERENCE BETWEEN THE SURFACE AND 400 FT (T_0-T_{400})

2

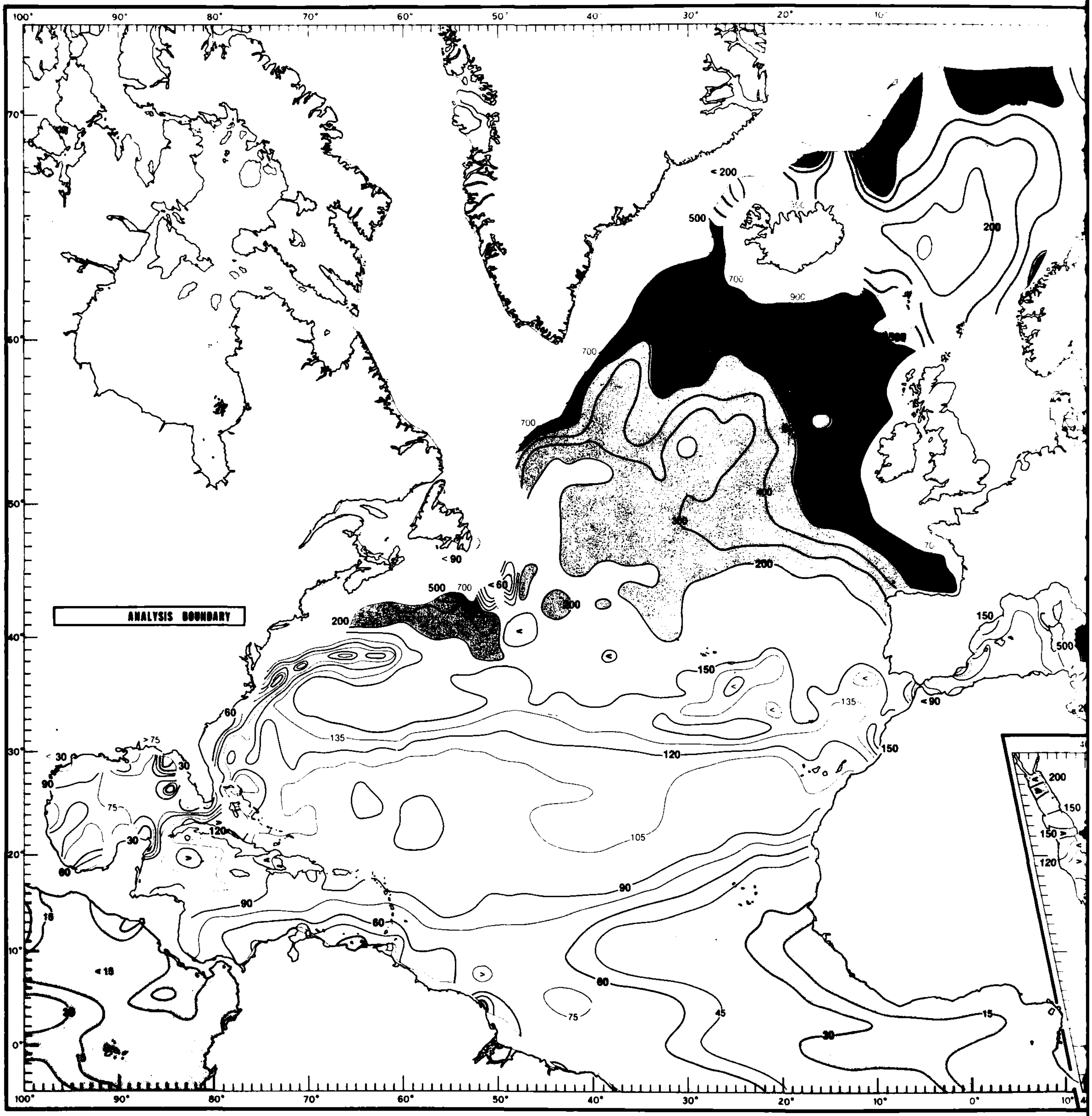
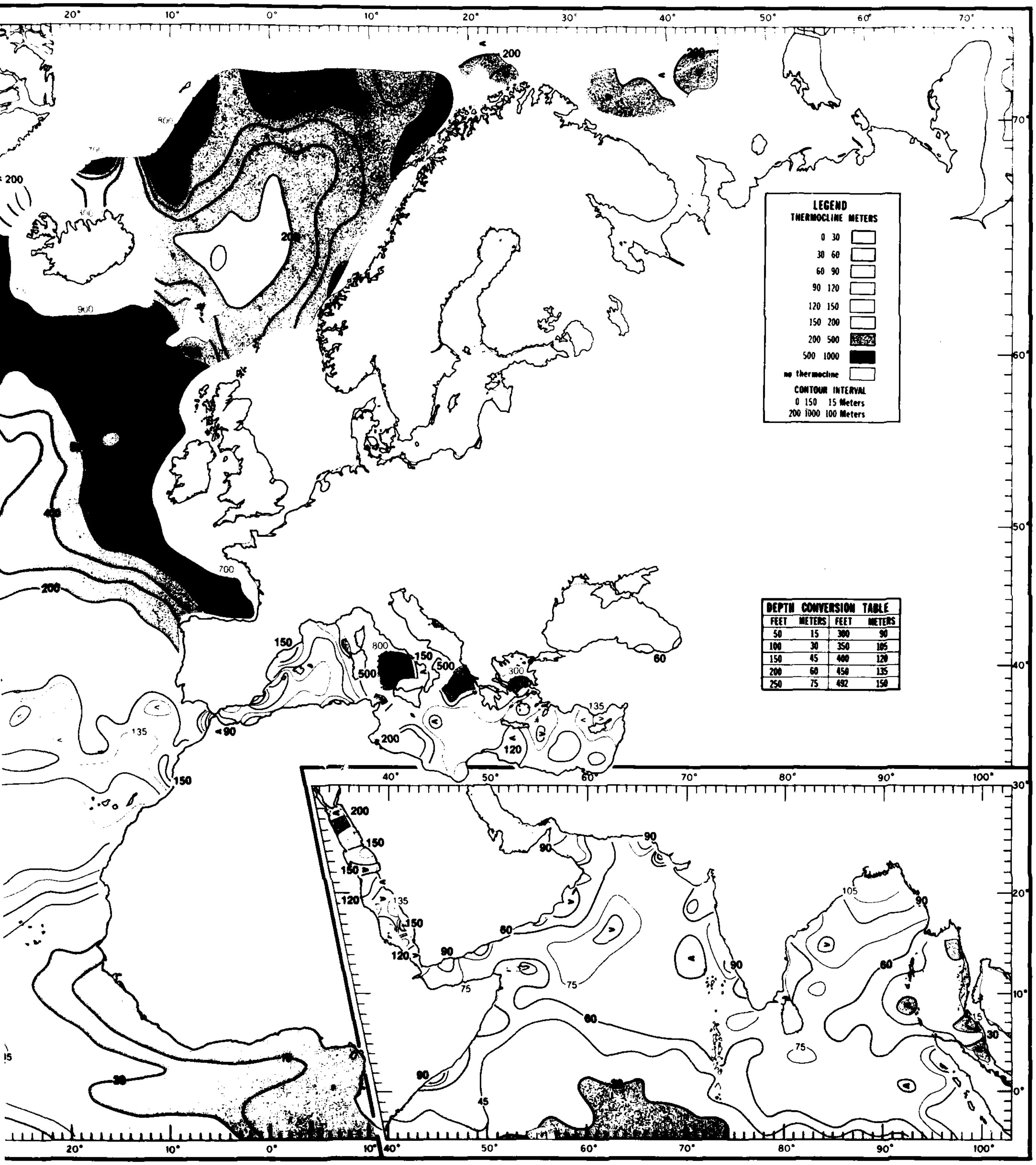


FIGURE 14. JANUARY MEAN DEPTHS TO THE TOP OF THE THERMO

1



DEPTH CONVERSION TABLE			
FEET	METERS	FEET	METERS
50	15	300	90
100	30	350	105
150	45	400	120
200	60	450	135
250	75	492	150

UARY MEAN DEPTHS TO THE TOP OF THE THERMOCLINE

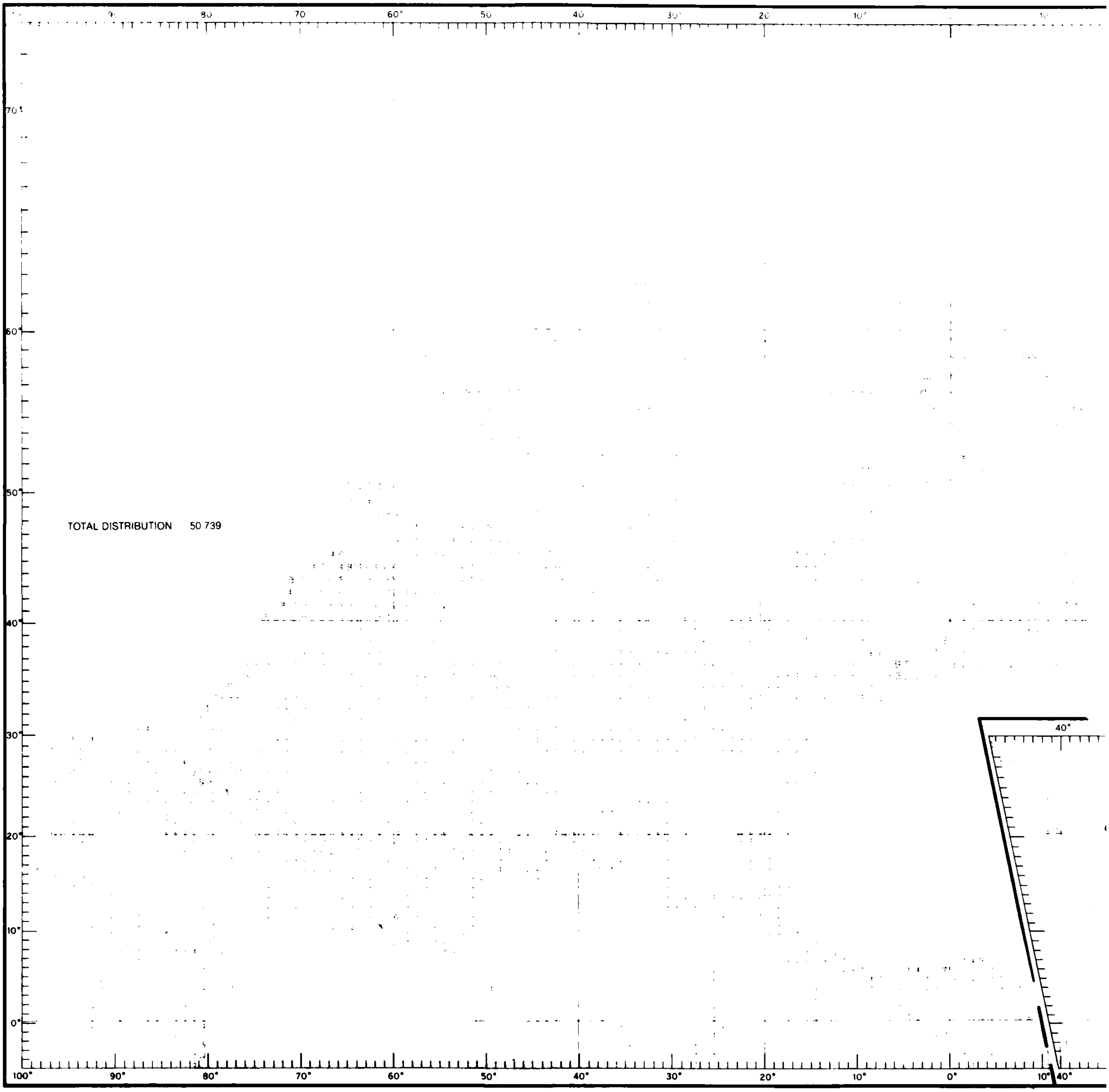
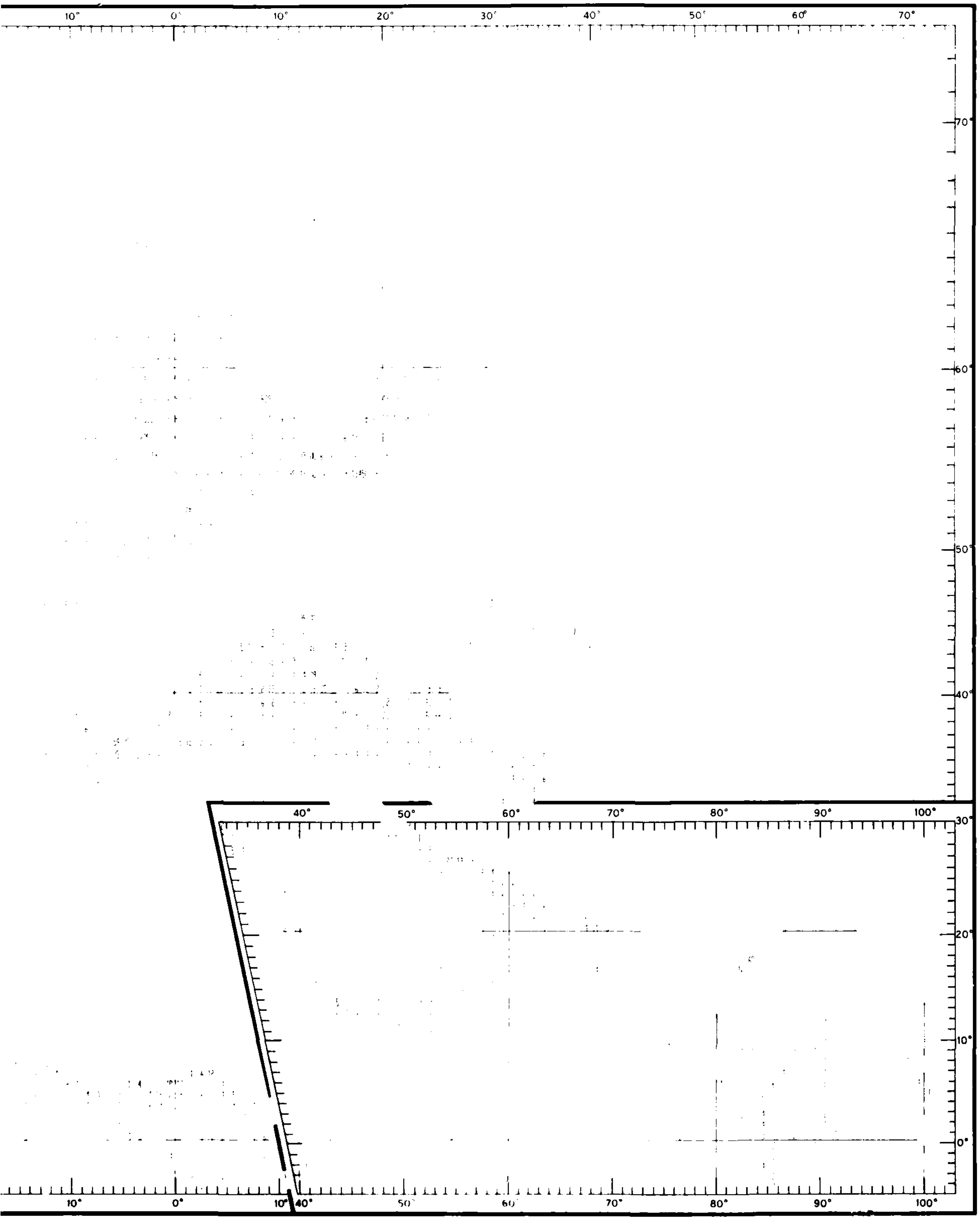


FIGURE 15. FEBRUARY DATA DISTRIBUTION OF TEMPERATURES AT THE SURFACE

1



BUTION OF TEMPERATURES AT THE SURFACE

1 2

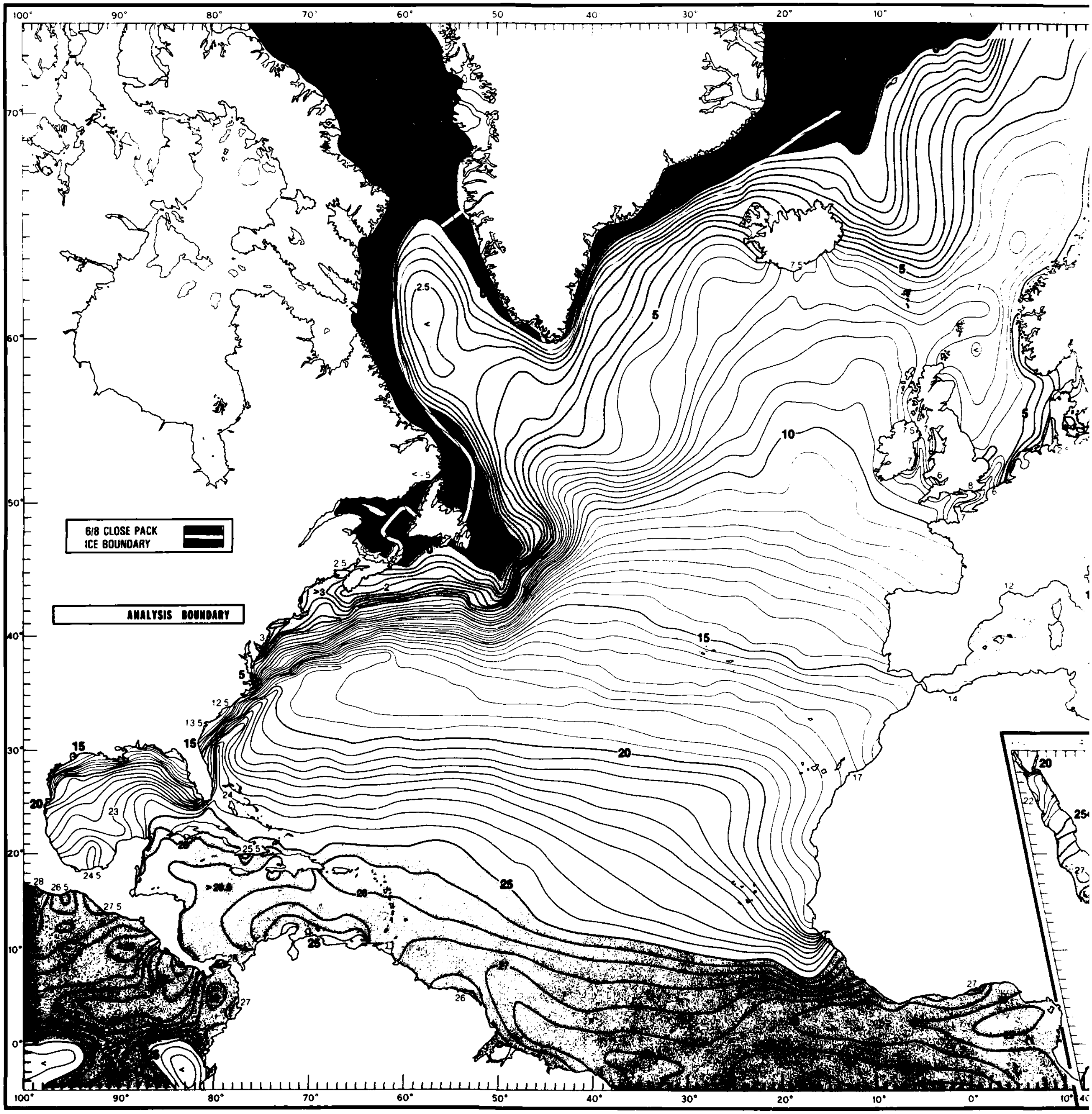
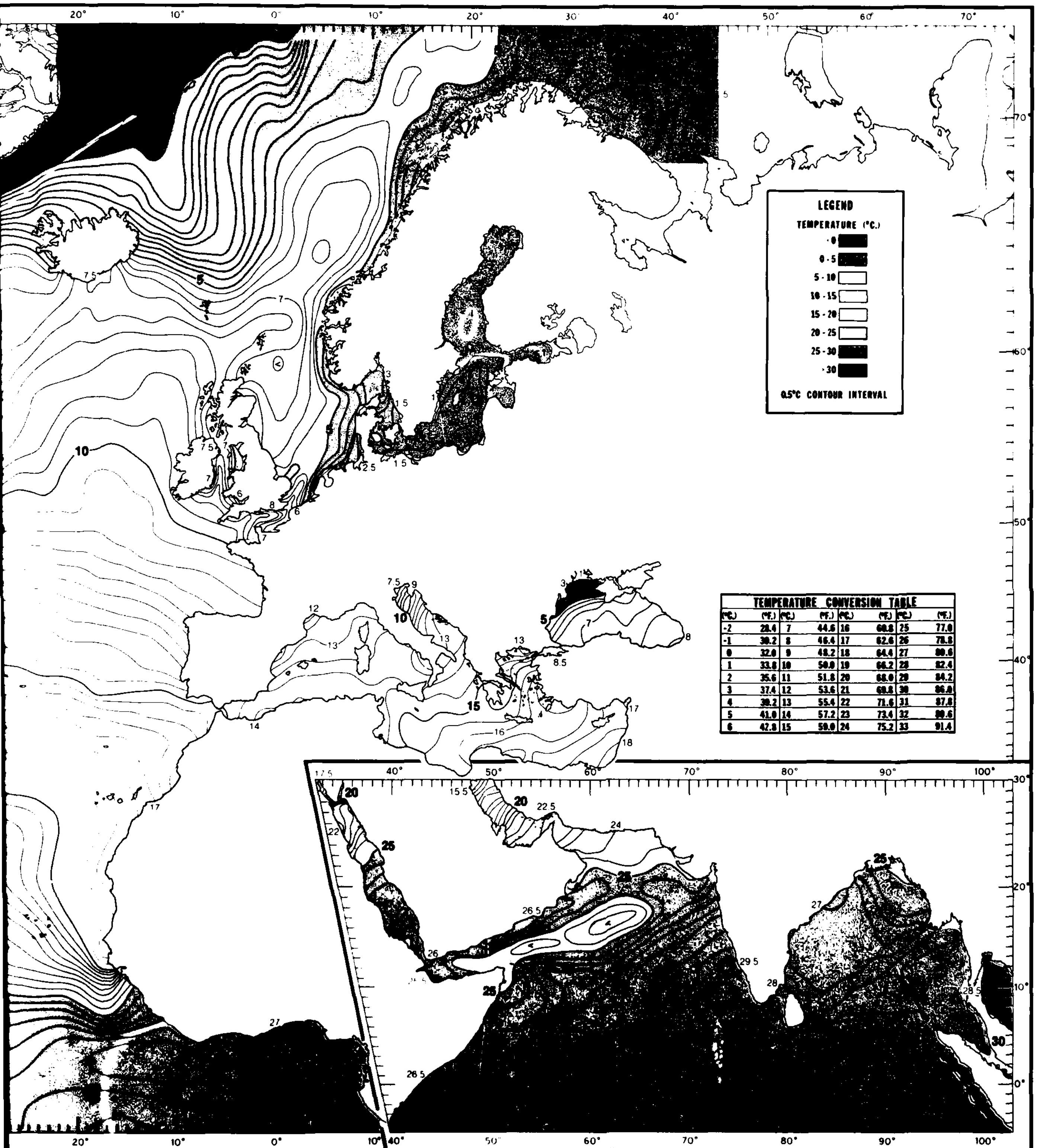


FIGURE 16. FEBRUARY MEAN TEMPERATURES AT THE SURFACE



TEMPERATURE CONVERSION TABLE

(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

RUARY MEAN TEMPERATURES AT THE SURFACE

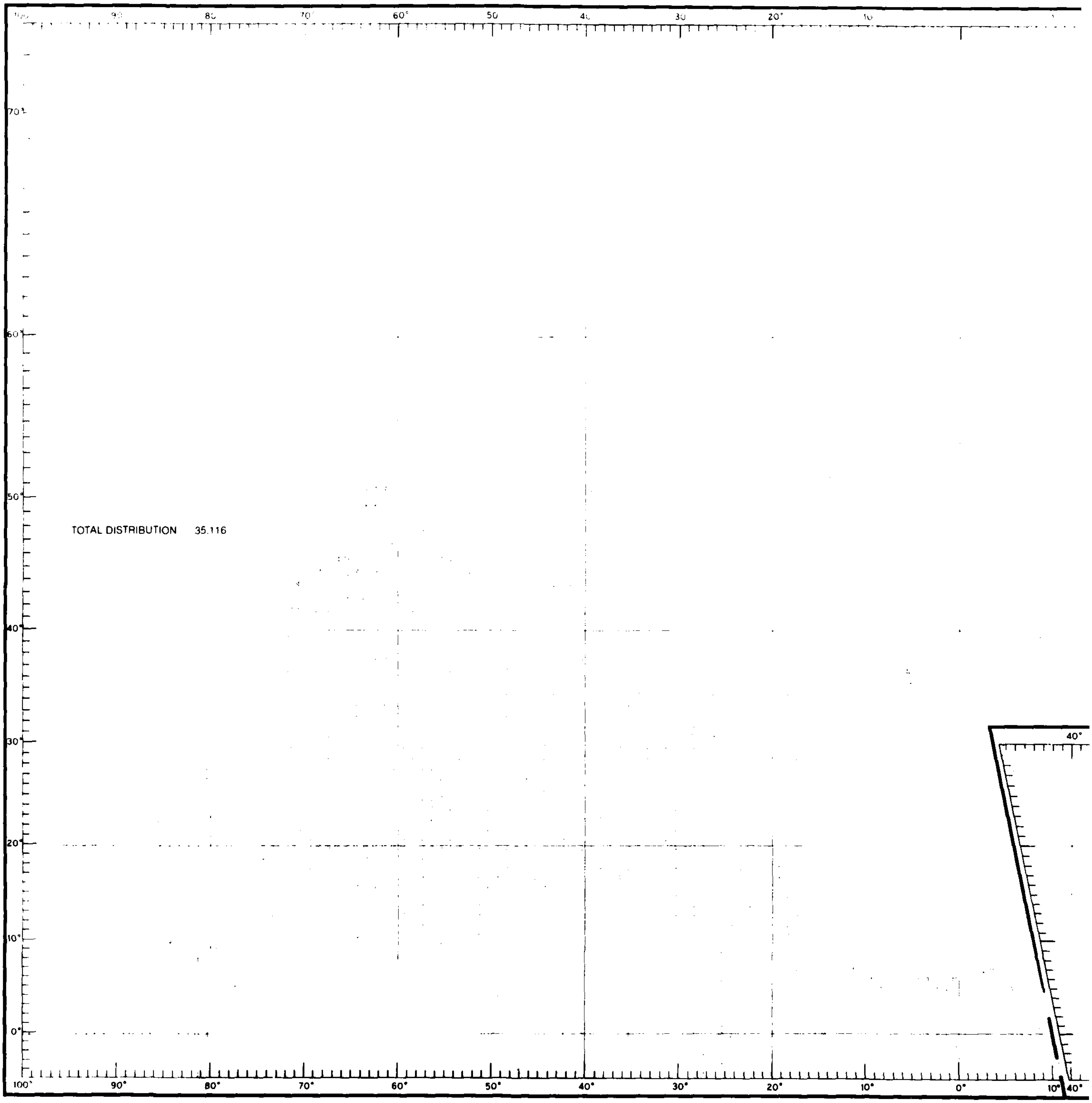
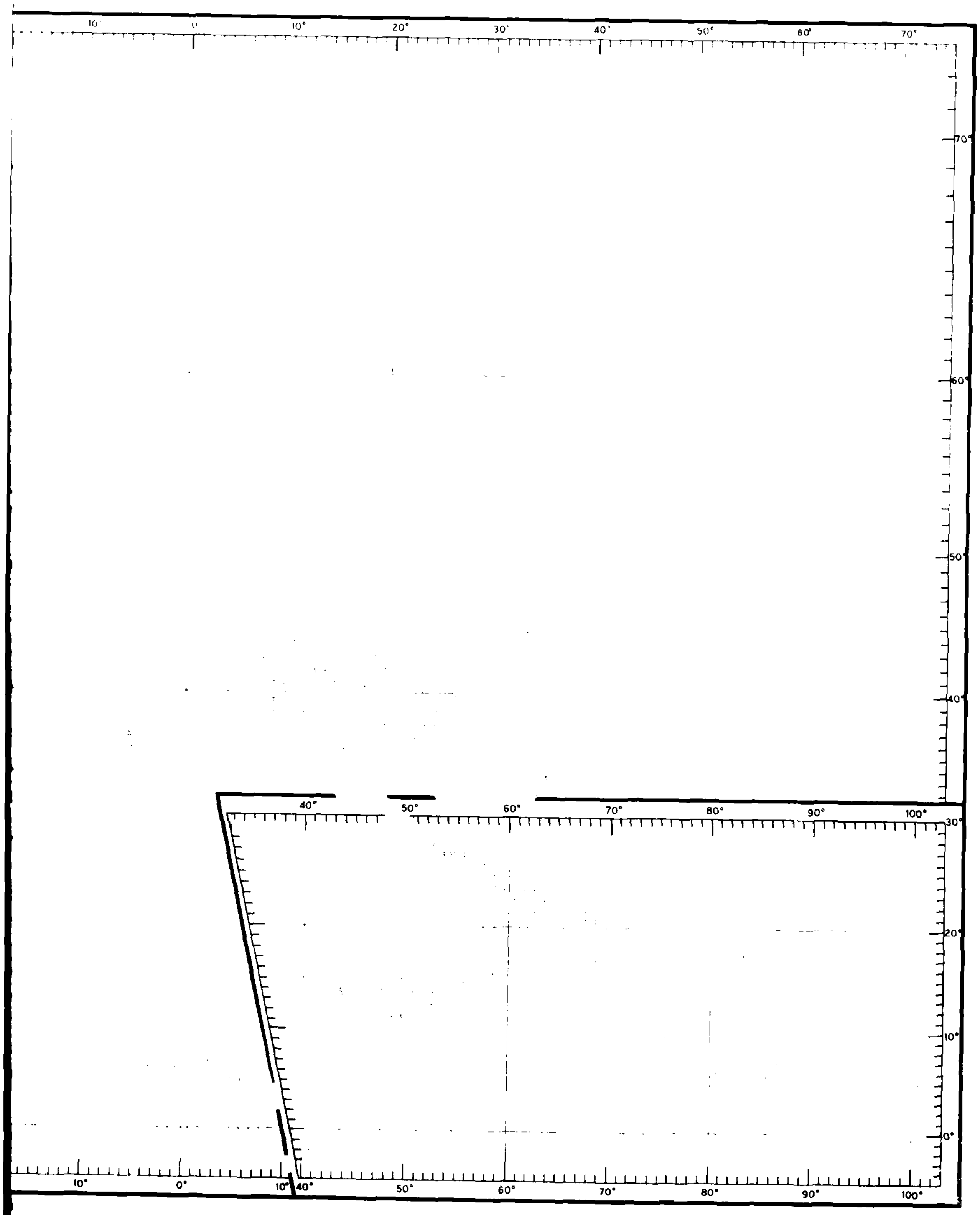


FIGURE 17. FEBRUARY DATA DISTRIBUTION OF TEMPERATURES AT 100 FT (30



BUTION OF TEMPERATURES AT 100 FT (30 M)

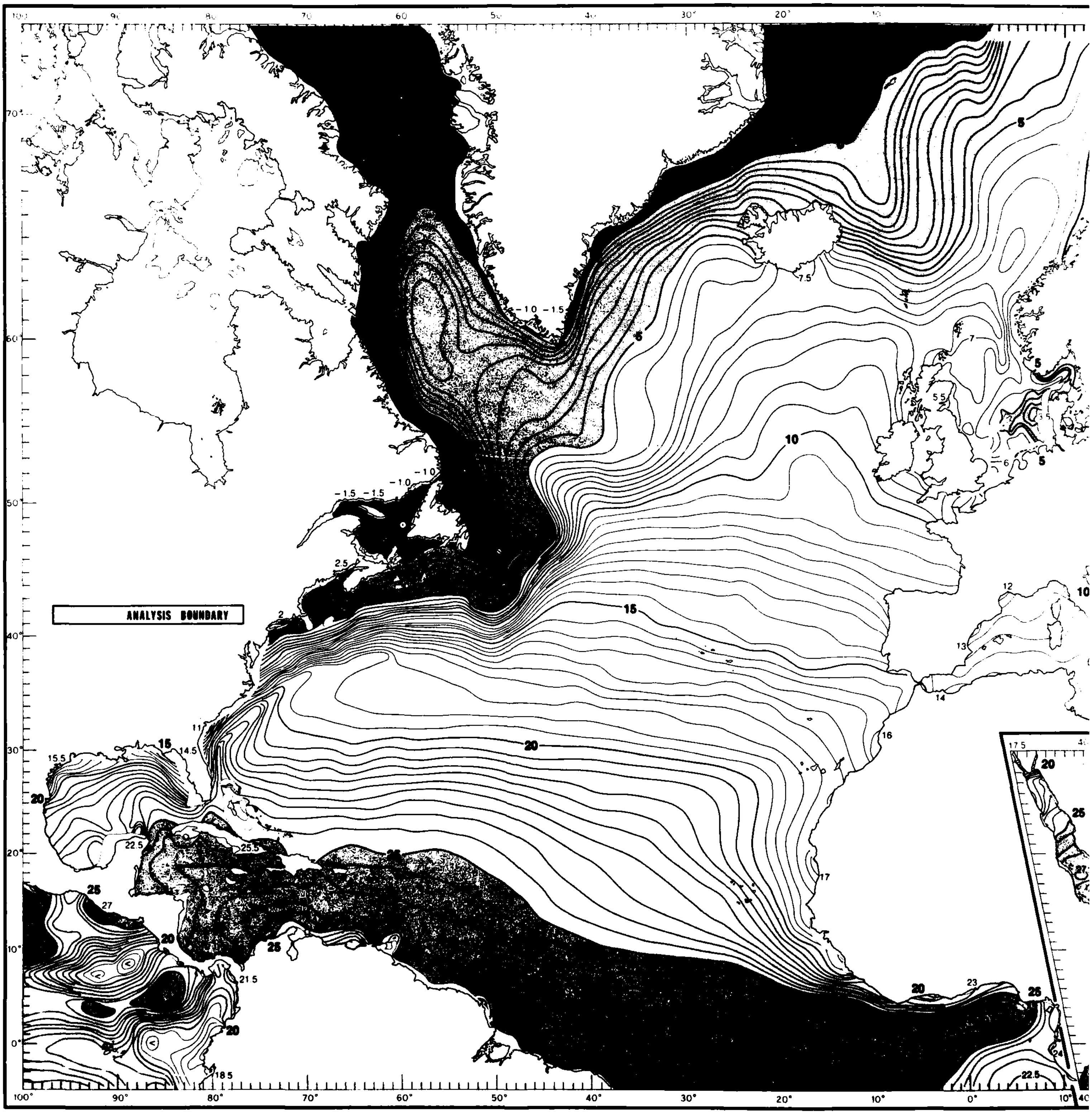
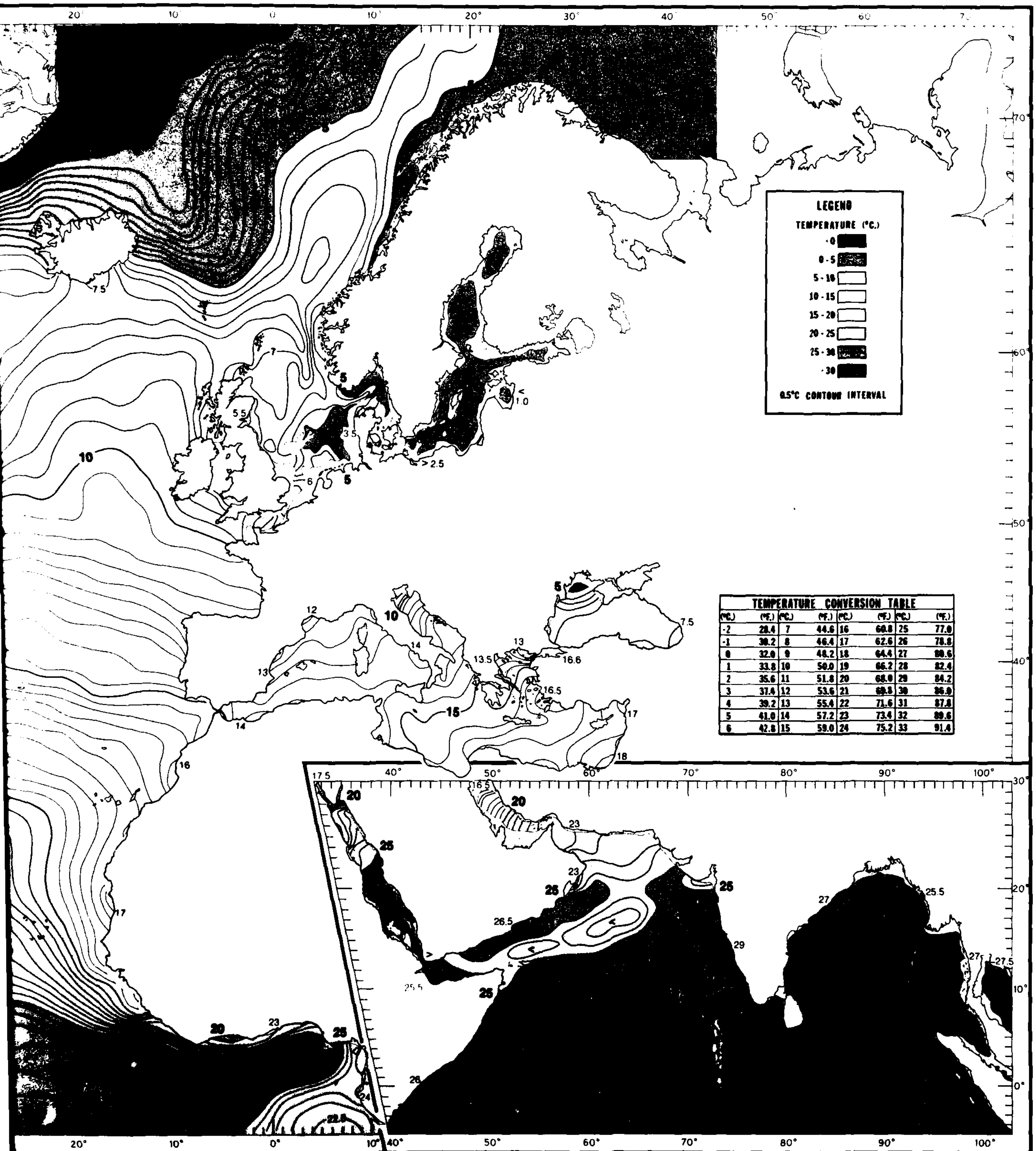


FIGURE 18. FEBRUARY MEAN TEMPERATURES AT 100 FT (30 M)



TEMPERATURE CONVERSION TABLE

(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

RY MEAN TEMPERATURES AT 100 FT (30 M)

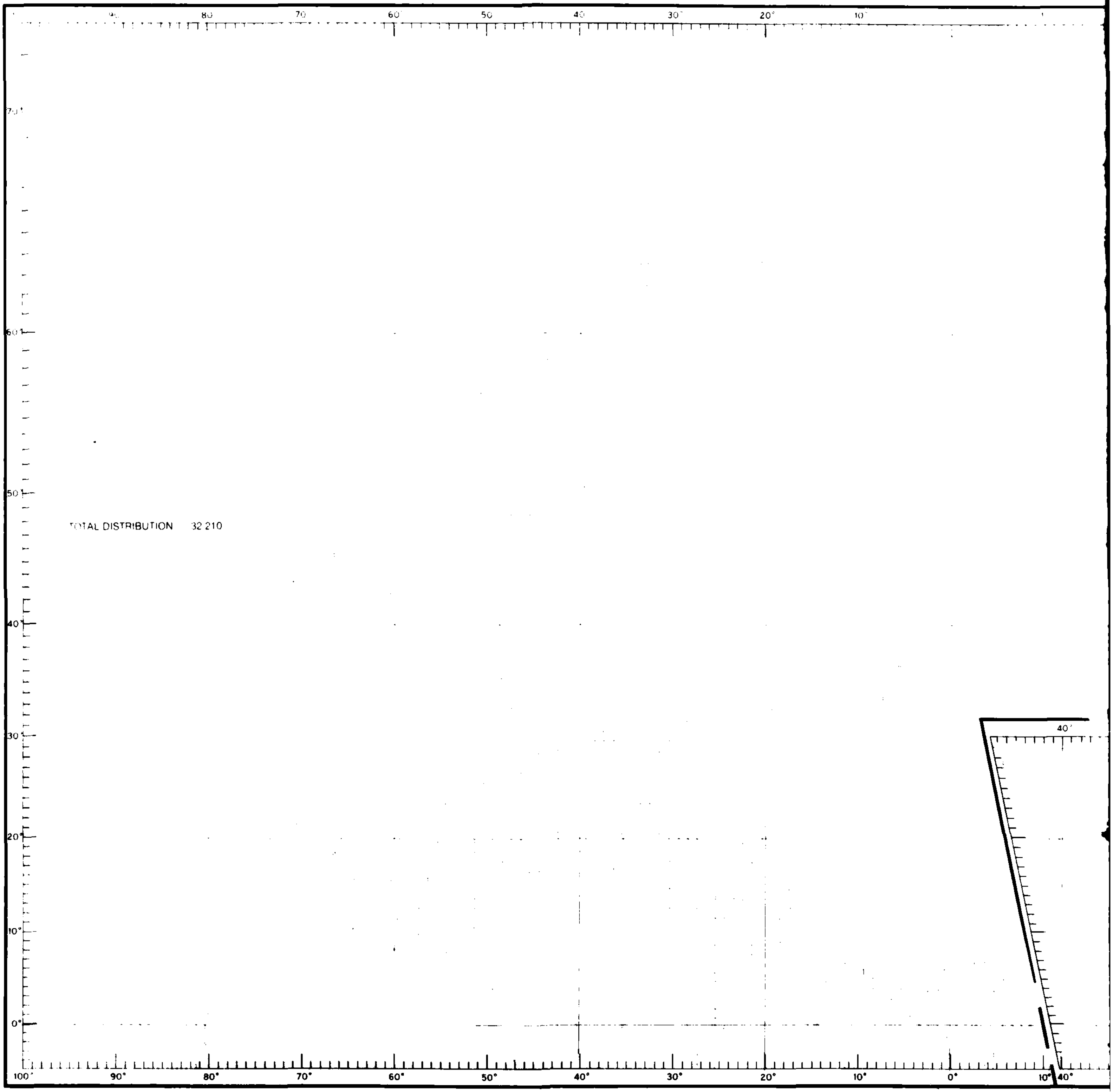
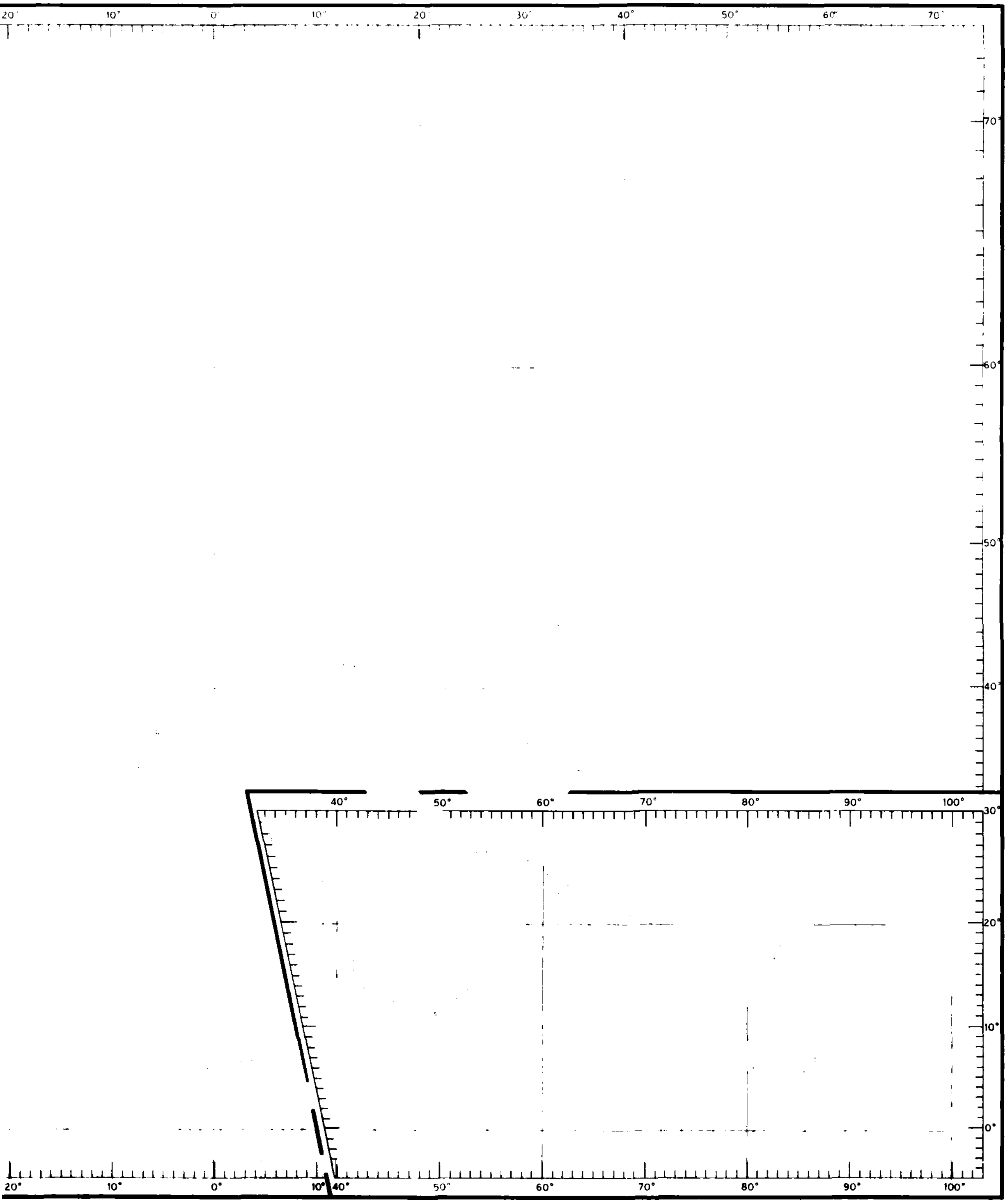


FIGURE 19. FEBRUARY DATA DISTRIBUTION OF TEMPERATURES AT 200 FT (60 M)

1



ISTRIBUTION OF TEMPERATURES AT 200 FT (60 M)

2

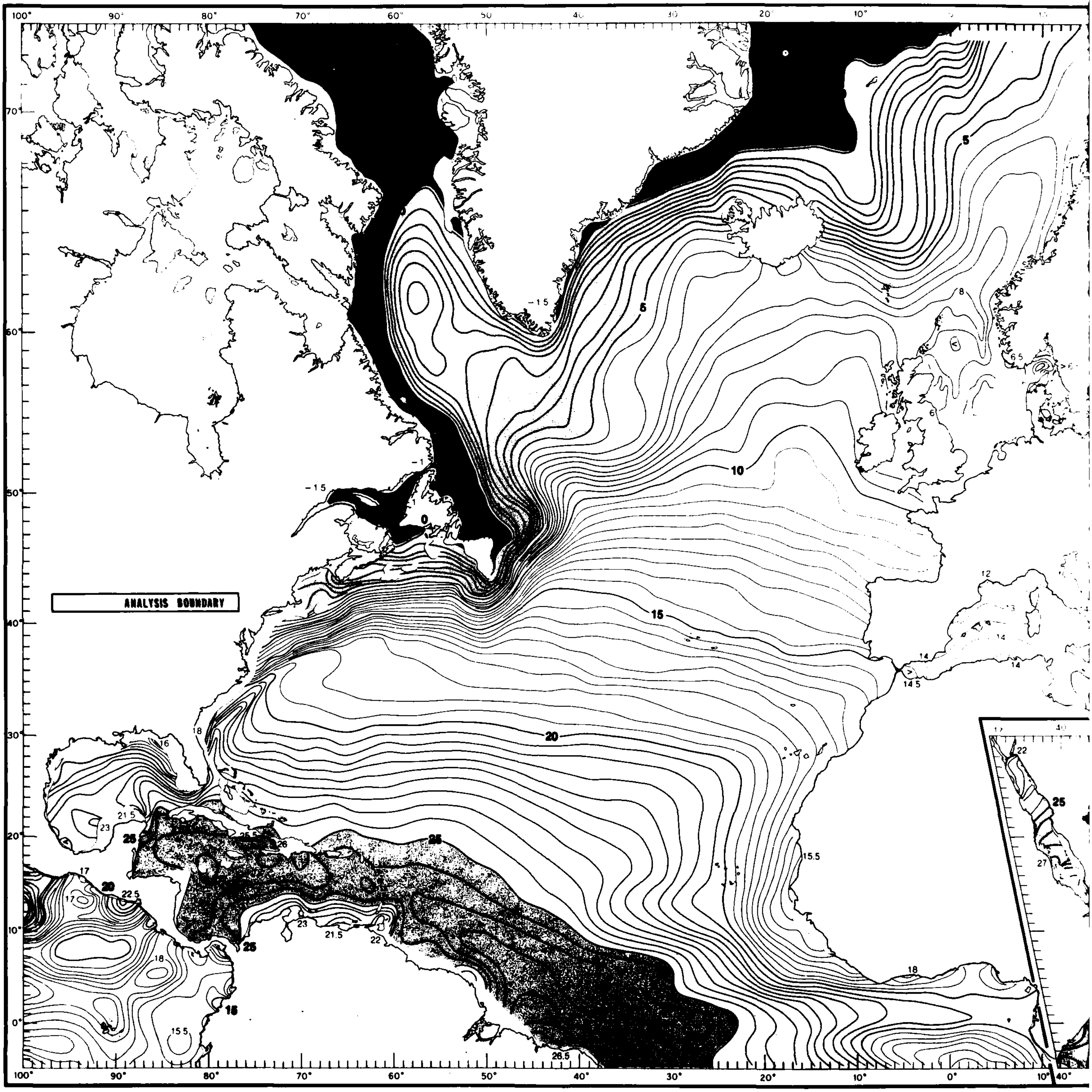
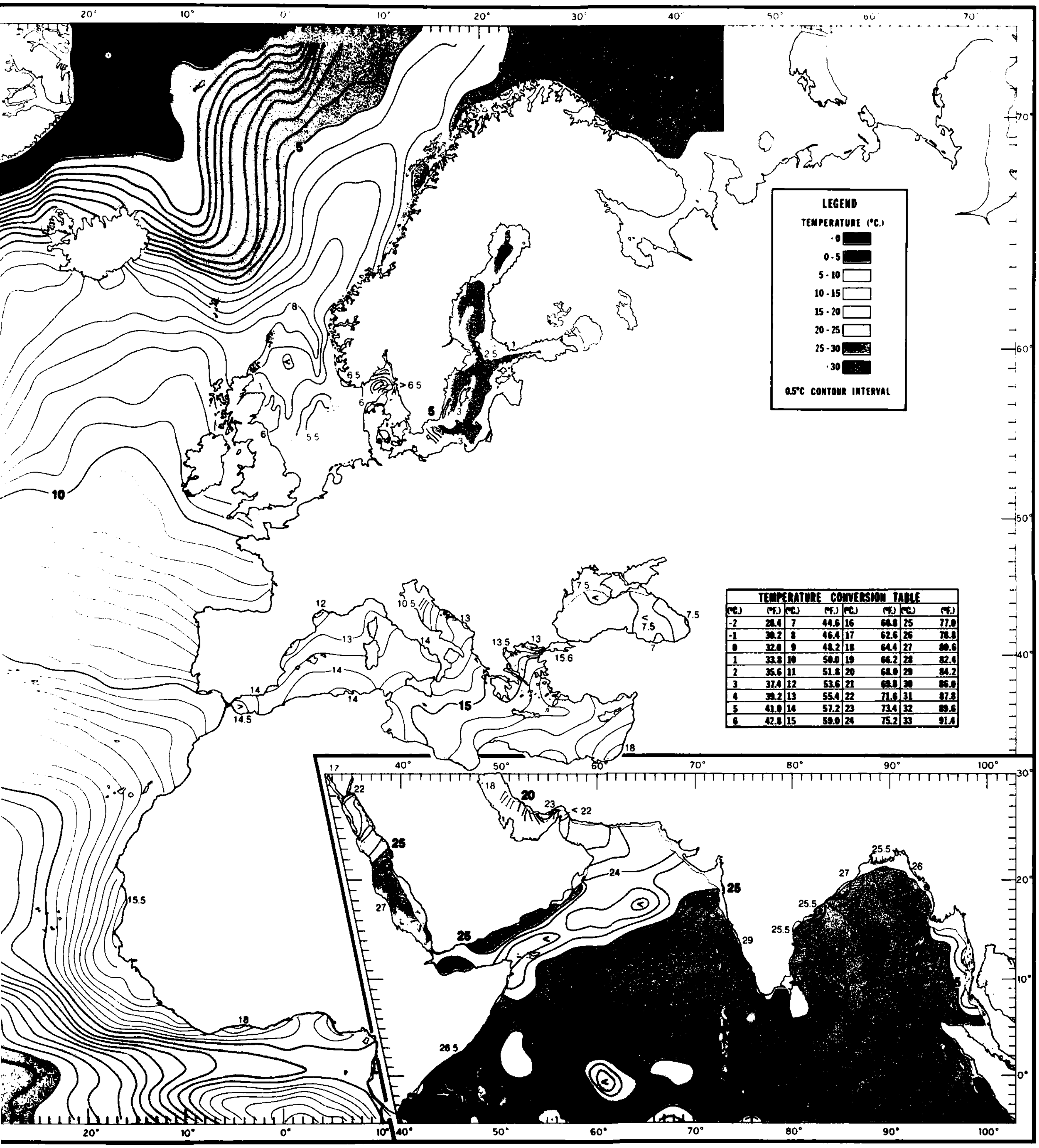


FIGURE 20. FEBRUARY MEAN TEMPERATURES AT 200 FT (60 M)

1



TEMPERATURE CONVERSION TABLE							
(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

EBRUARY MEAN TEMPERATURES AT 200 FT (60 M)

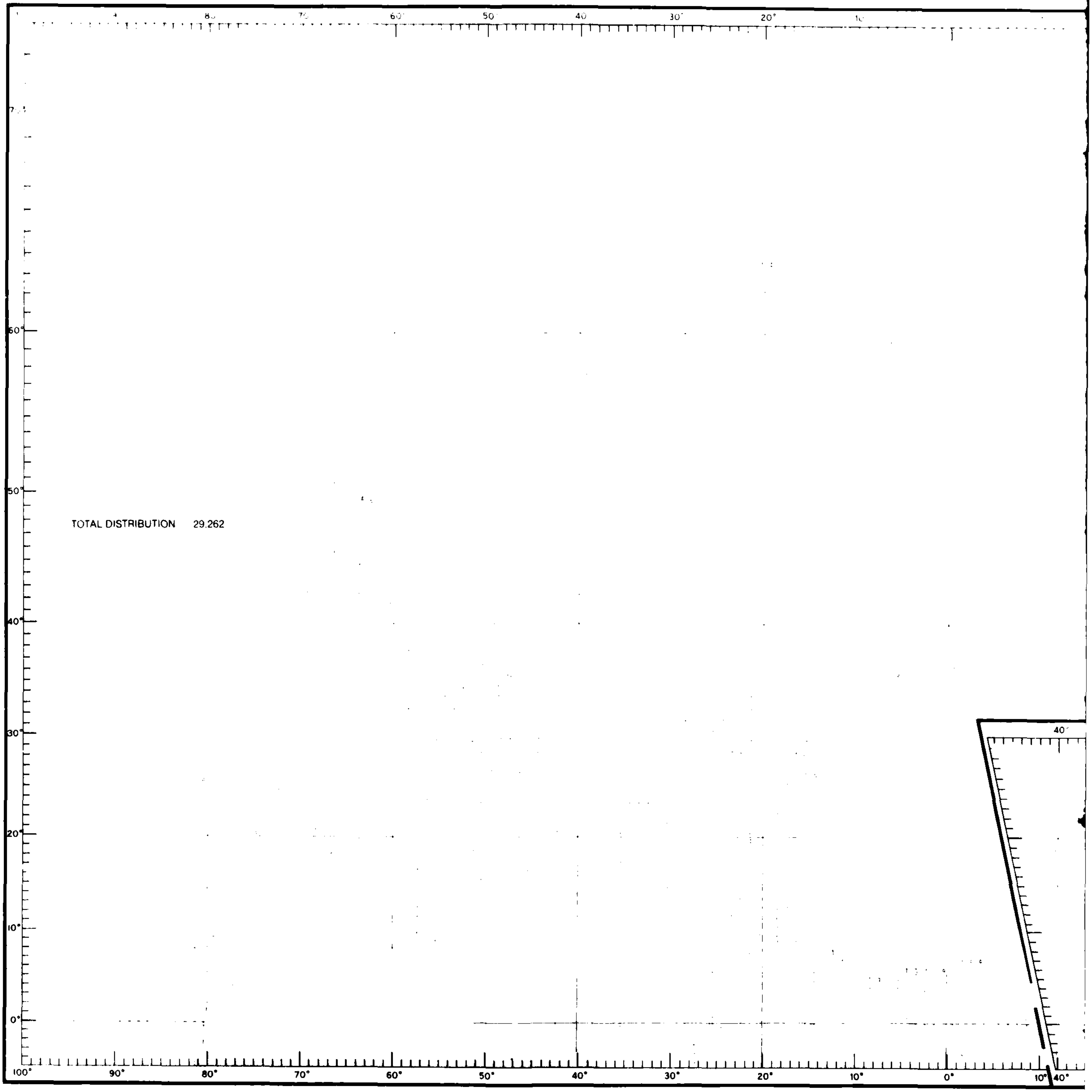
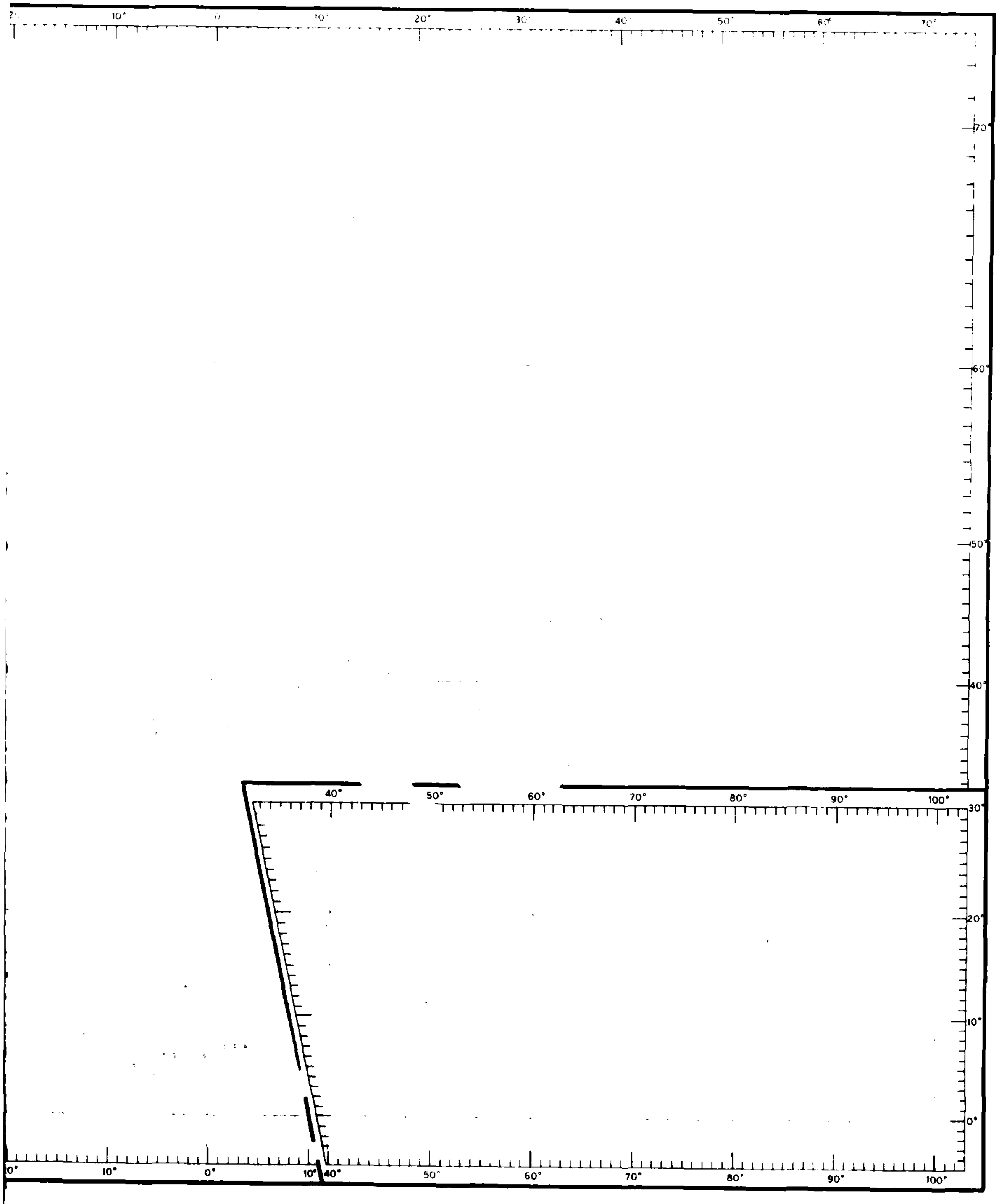


FIGURE 21. FEBRUARY DATA DISTRIBUTION OF TEMPERATURES AT 300 FT (90 M



TRIBUTION OF TEMPERATURES AT 300 FT (90 M)

2

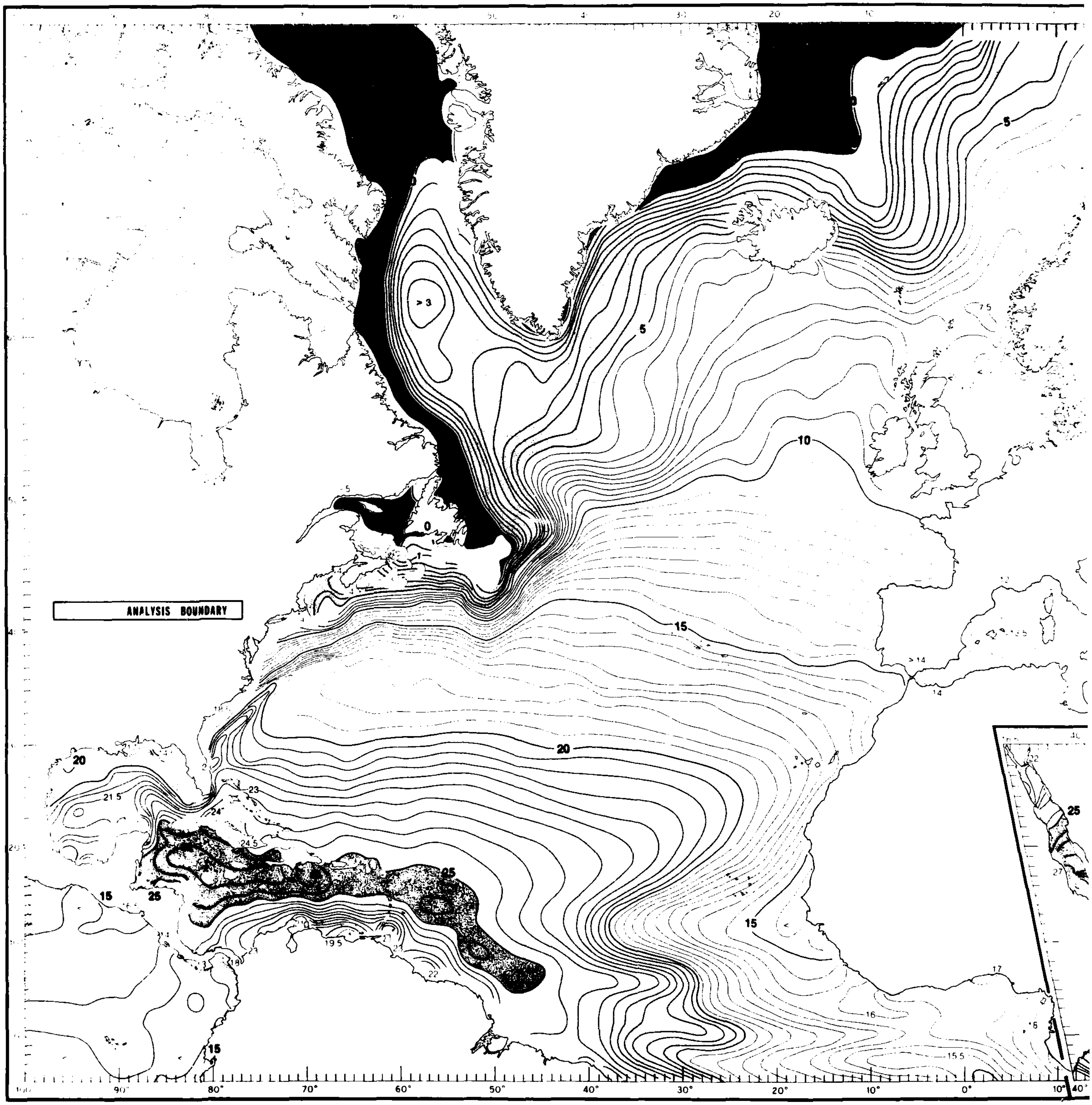
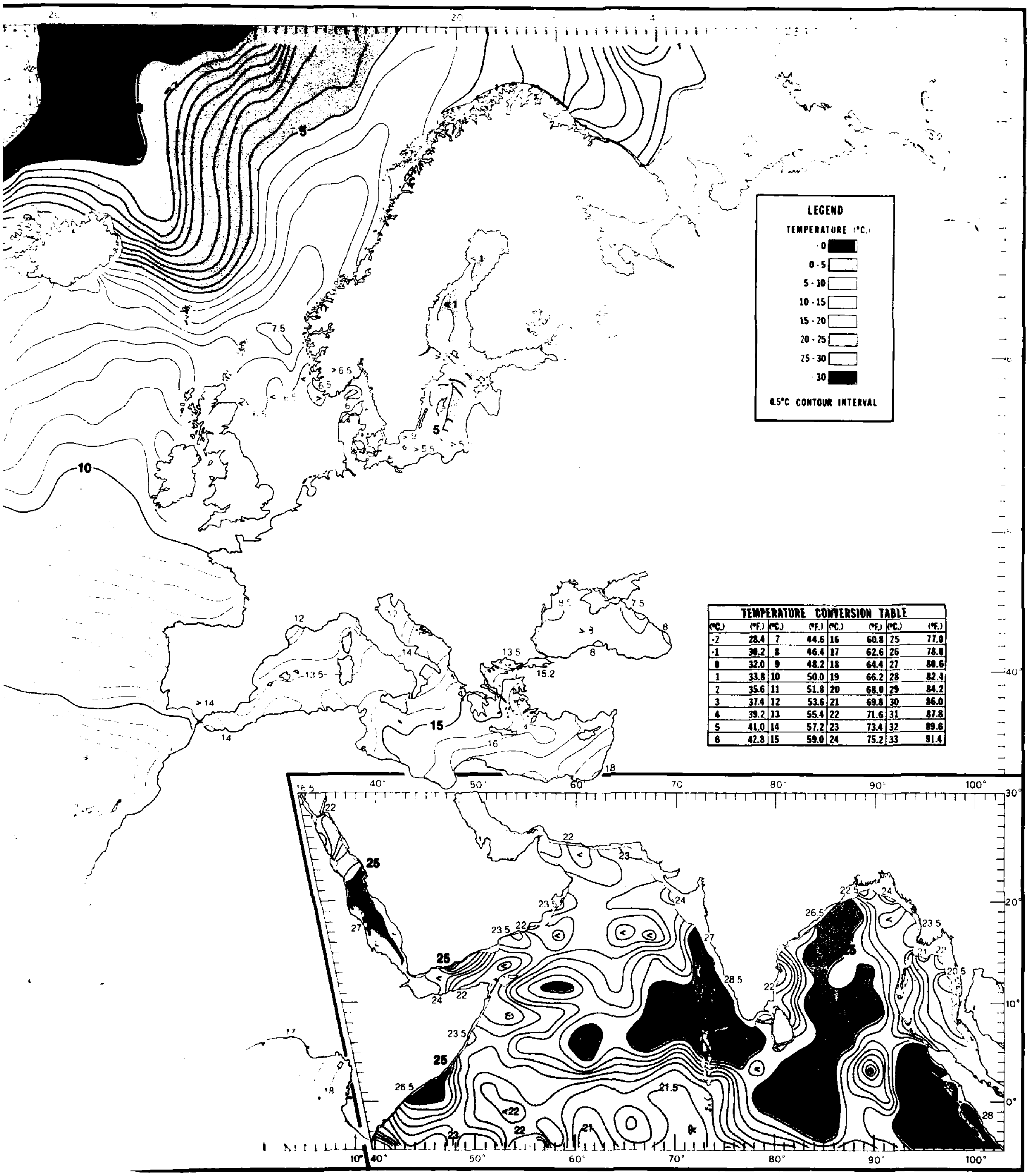


FIGURE 22. FEBRUARY MEAN TEMPERATURES AT 300 FT (90 M)



TEMPERATURE CONVERSION TABLE

(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

FT (90 M)

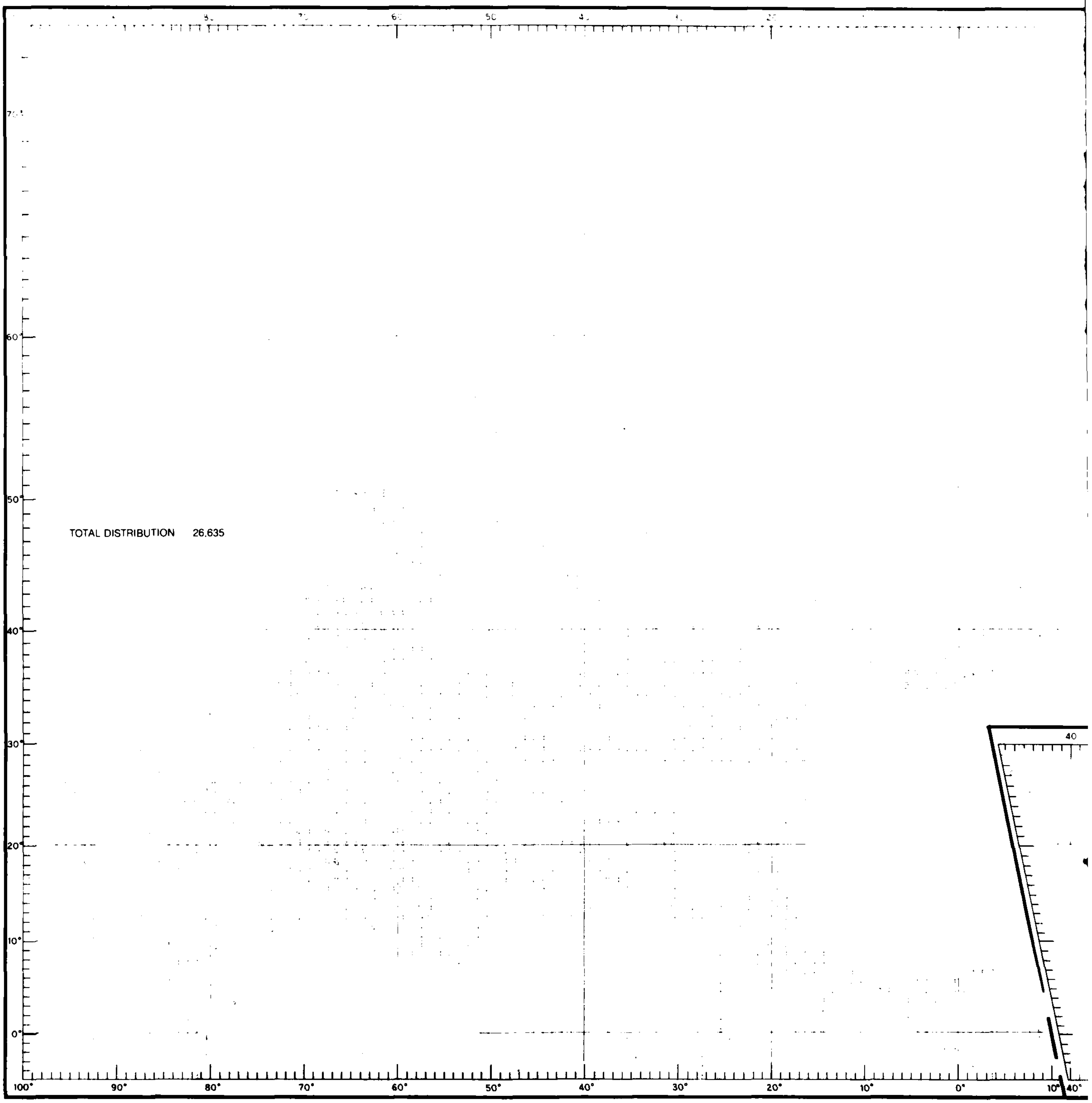
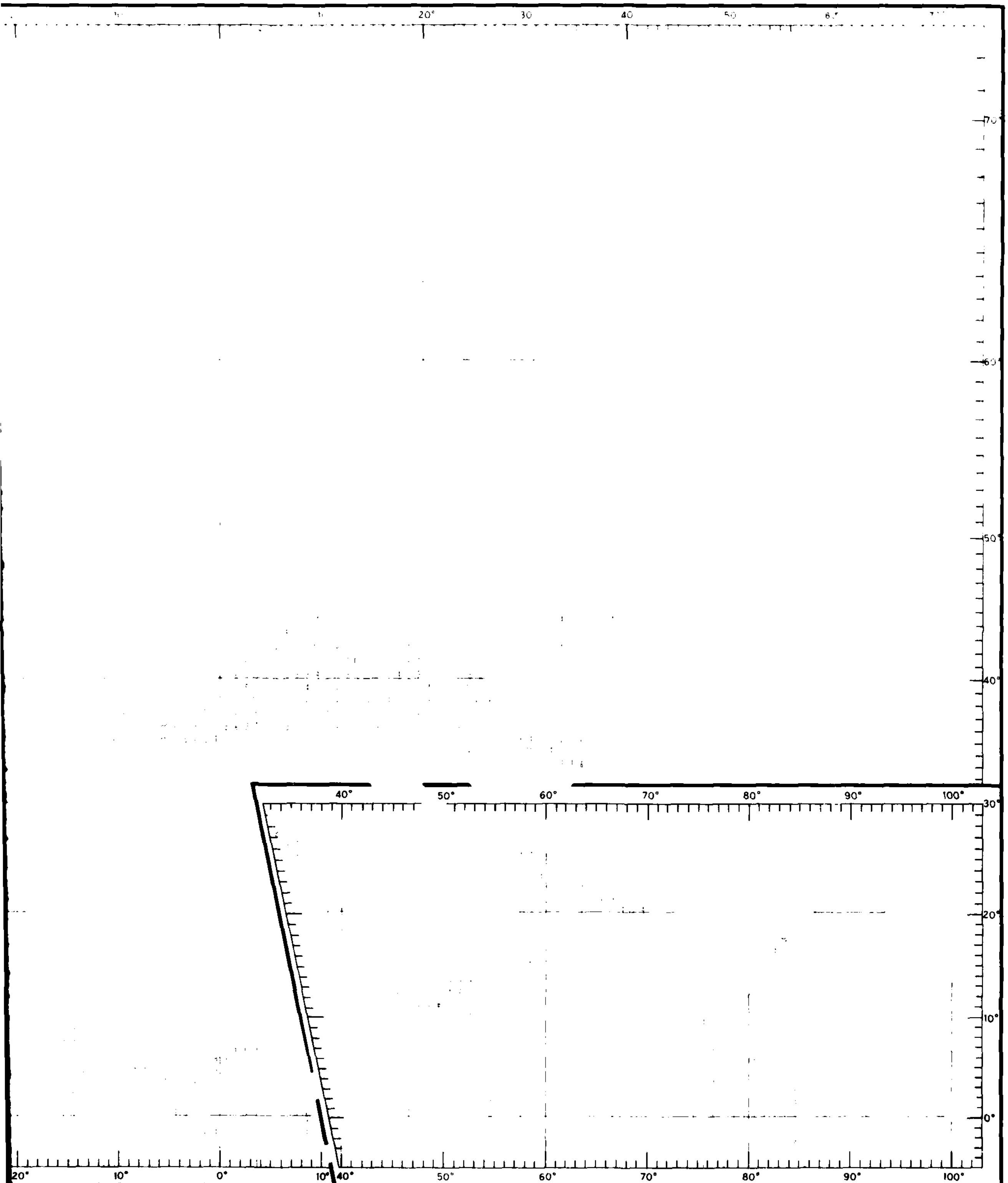


FIGURE 23. FEBRUARY DATA DISTRIBUTION OF TEMPERATURES AT 400 FT (12



STRIBUTION OF TEMPERATURES AT 400 FT (120 M)

1

2

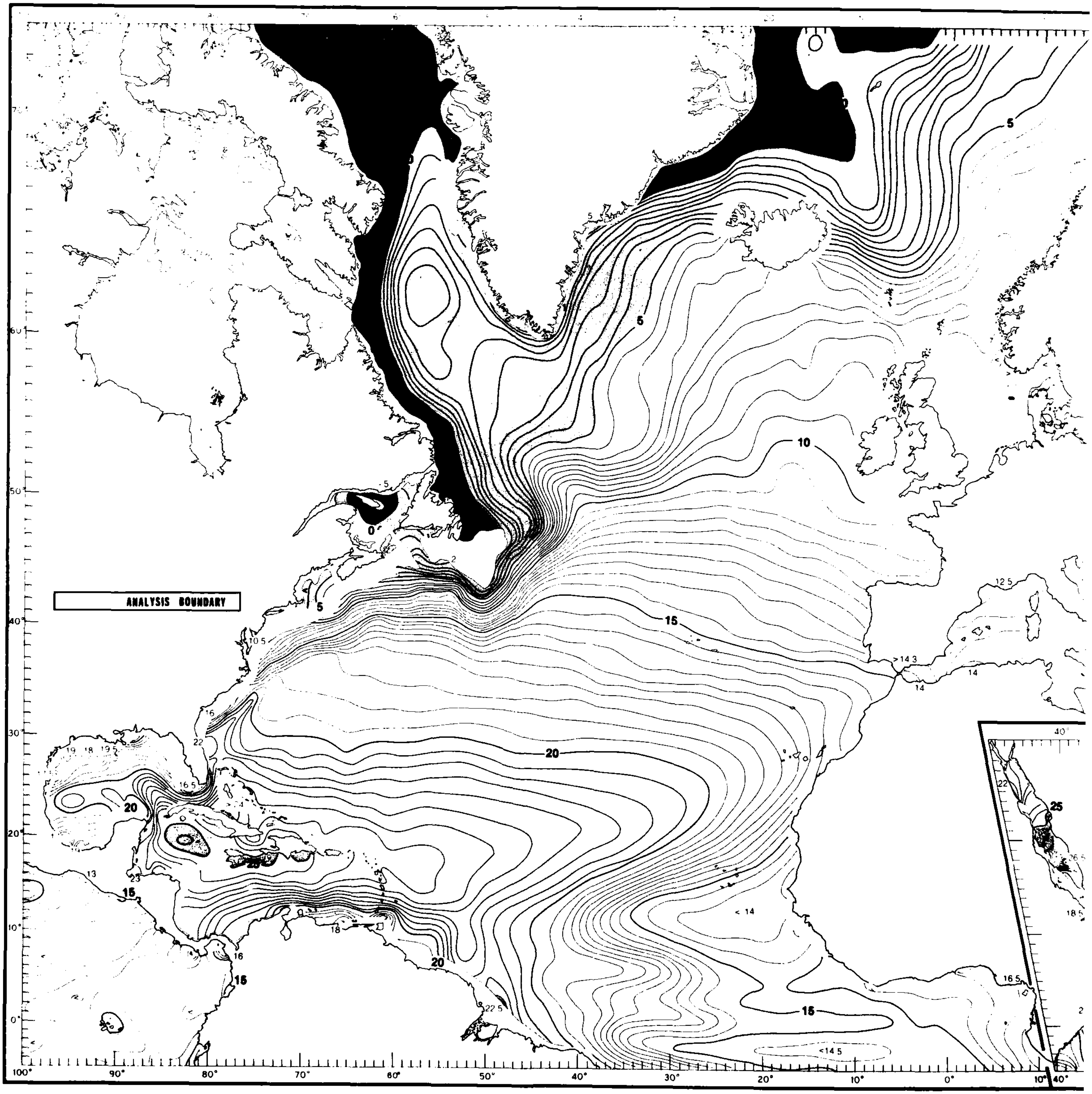
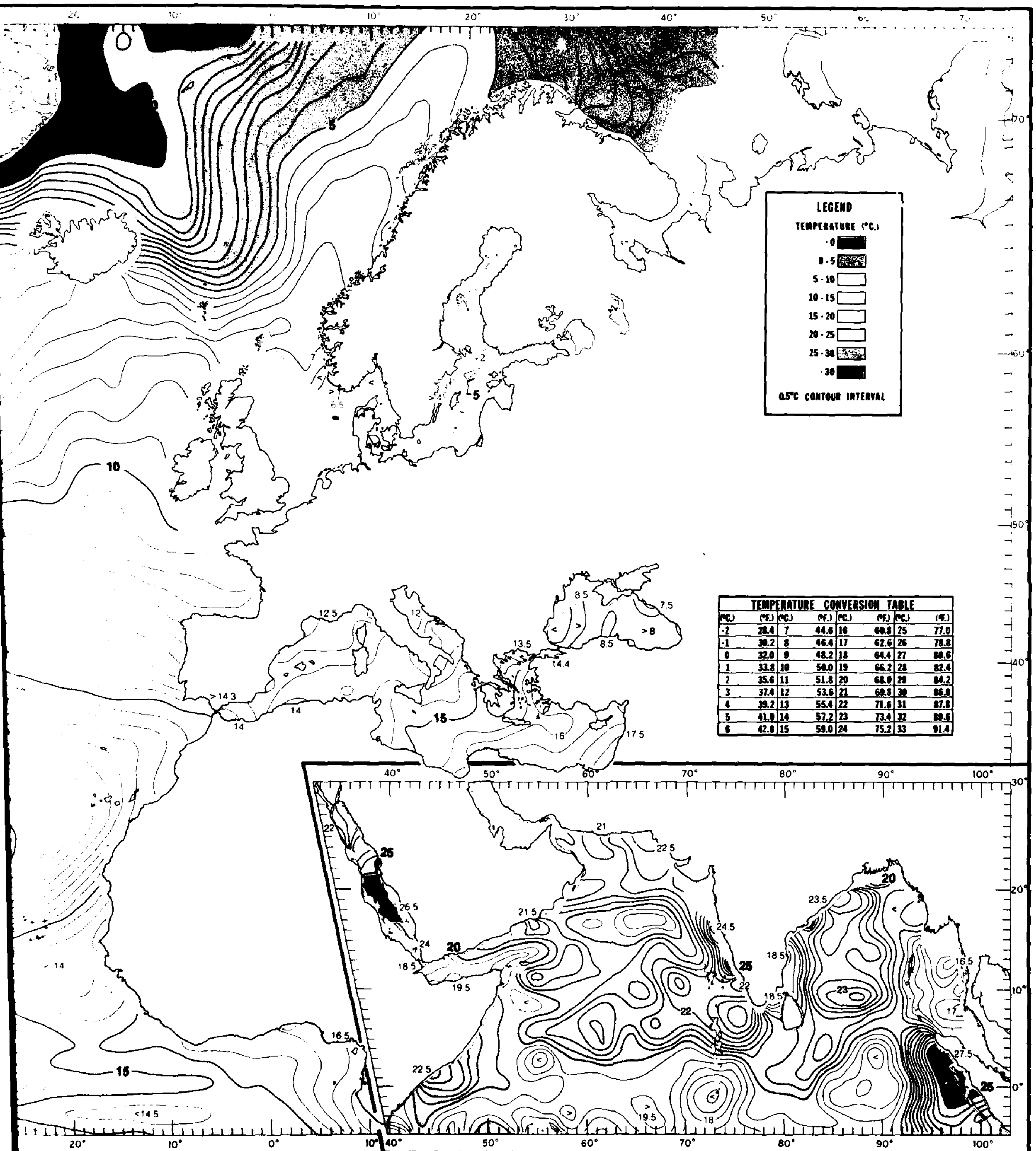


FIGURE 24. FEBRUARY MEAN TEMPERATURES AT 400 FT (120 M)



TEMPERATURE CONVERSION TABLE							
(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

RUARY MEAN TEMPERATURES AT 400 FT (120 M)

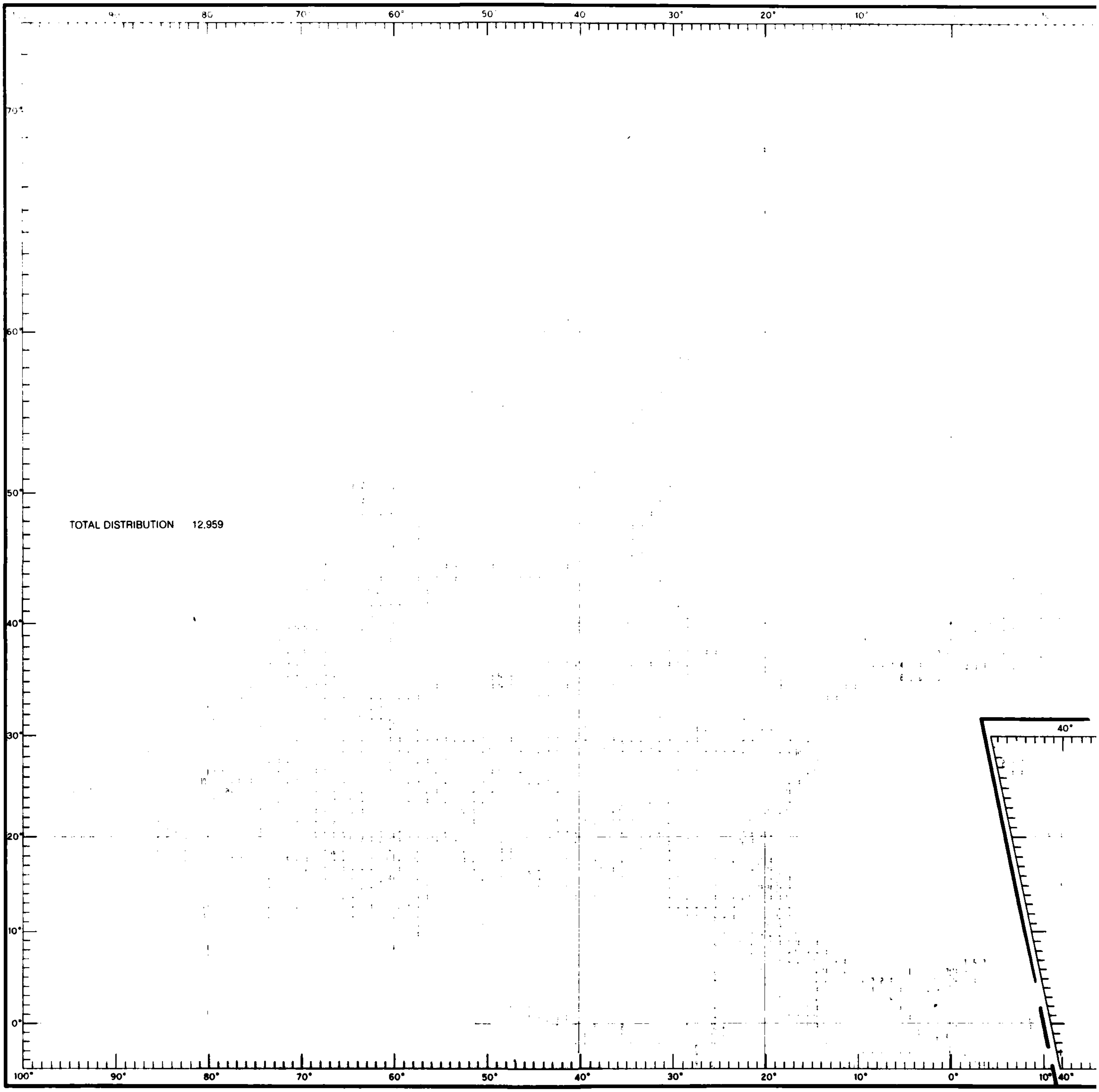
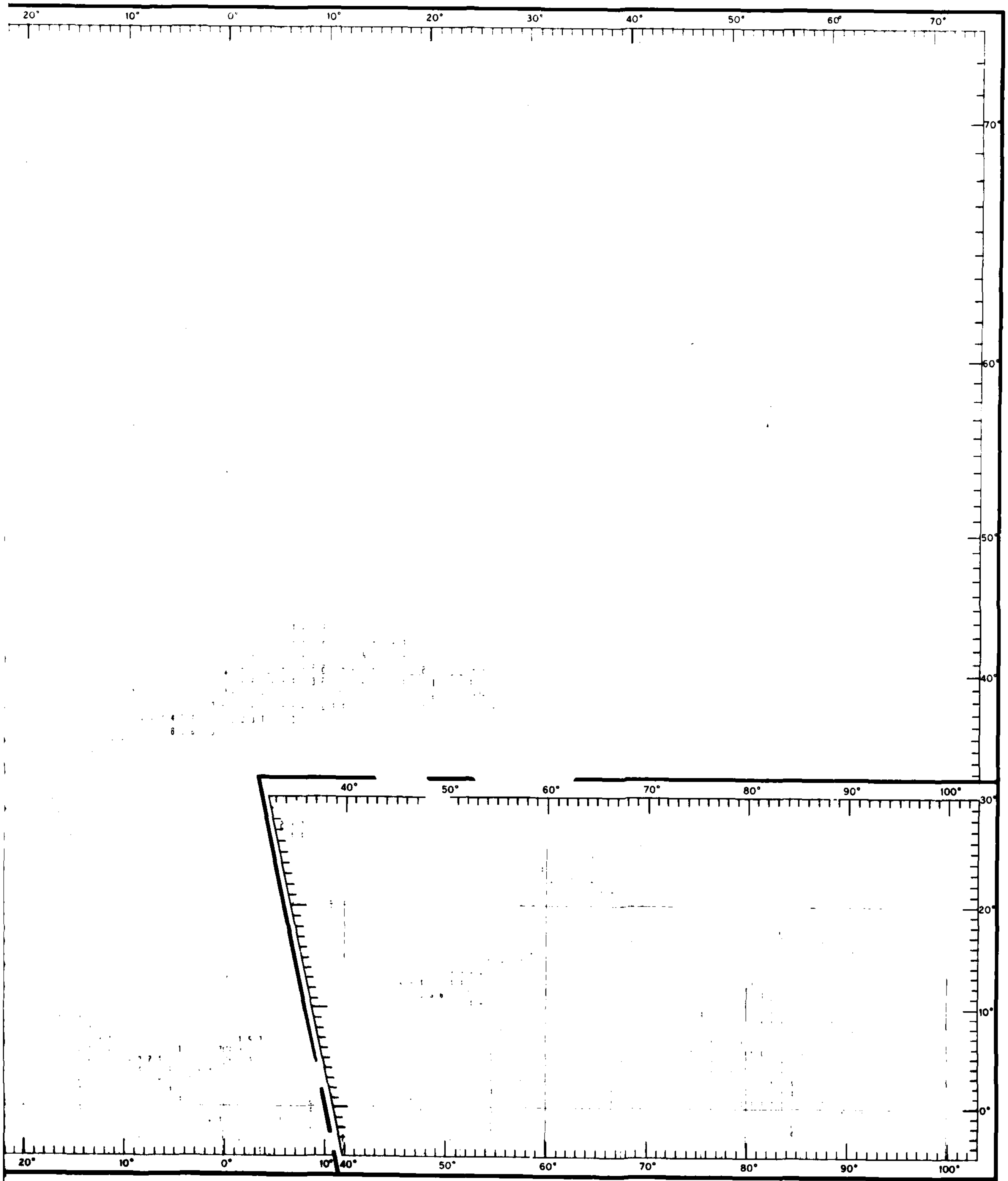


FIGURE 25. FEBRUARY DATA DISTRIBUTION OF TEMPERATURES AT 492 FT (150 M

1



DISTRIBUTION OF TEMPERATURES AT 492 FT (150 M)

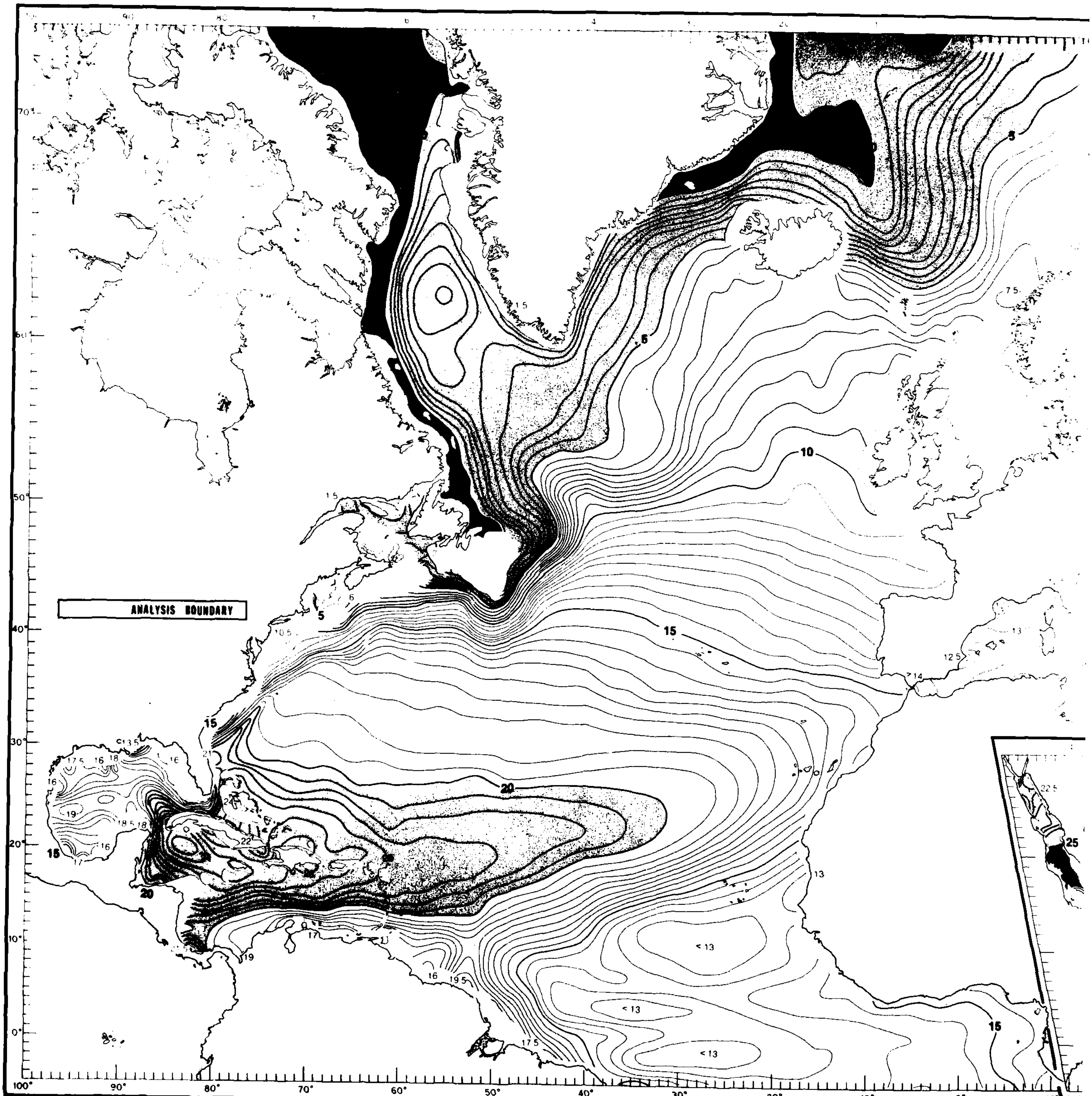
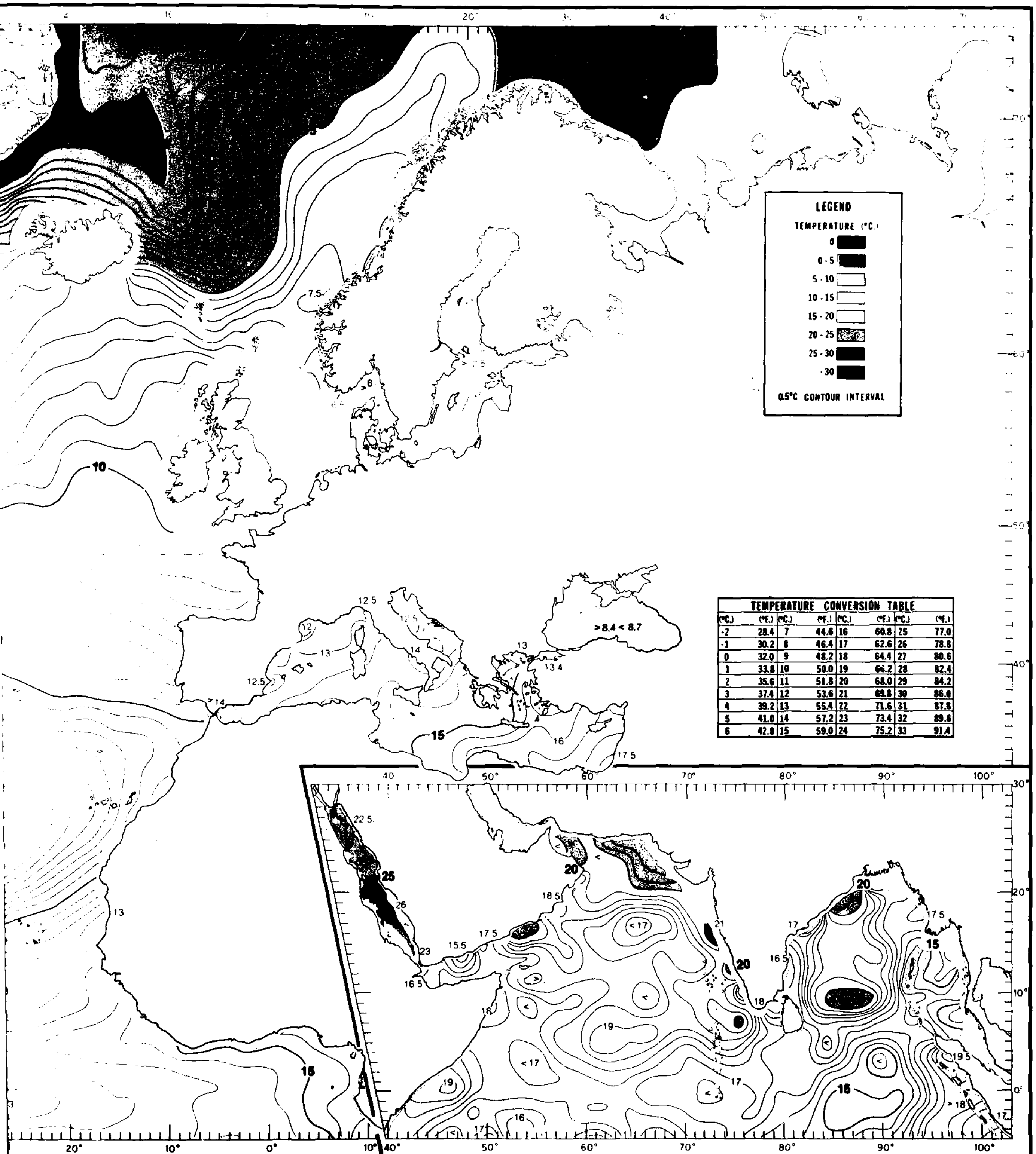


FIGURE 26. FEBRUARY MEAN TEMPERATURES AT 492 FT (150 M)



TEMPERATURE CONVERSION TABLE

(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

ARY MEAN TEMPERATURES AT 492 FT (150 M)

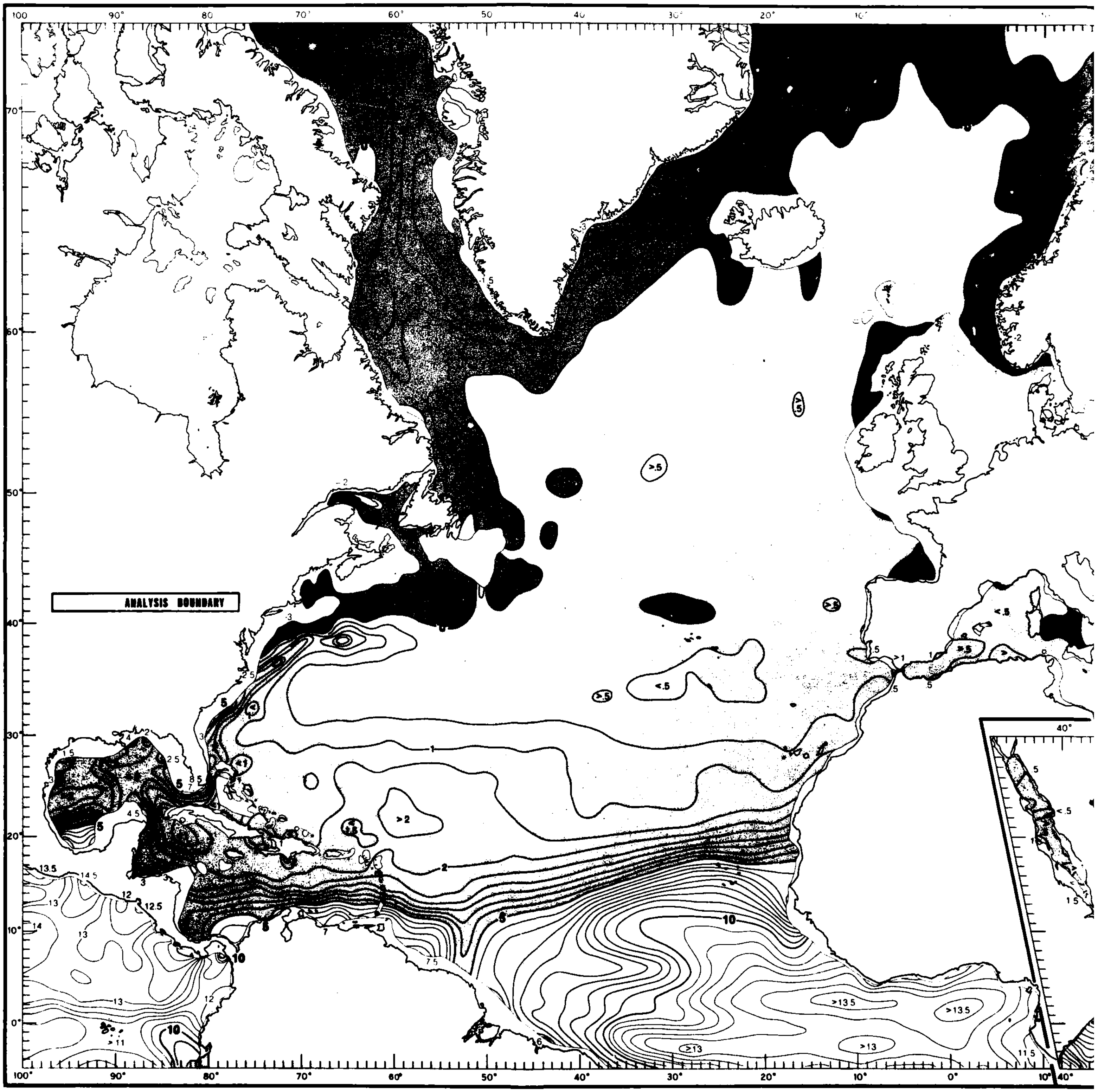
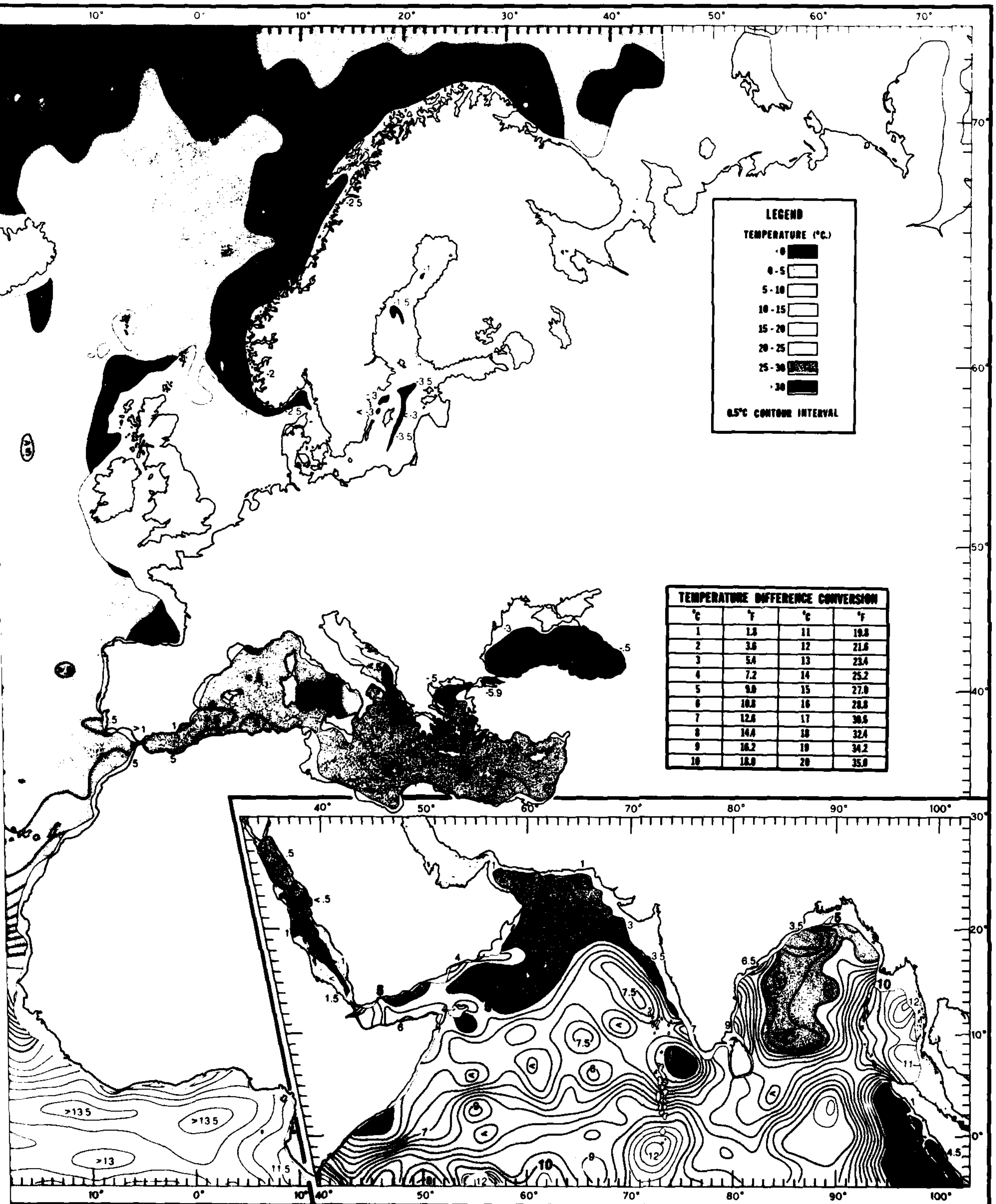


FIGURE 27. FEBRUARY TEMPERATURE DIFFERENCE BETWEEN THE SURFACE AND 400 FT (

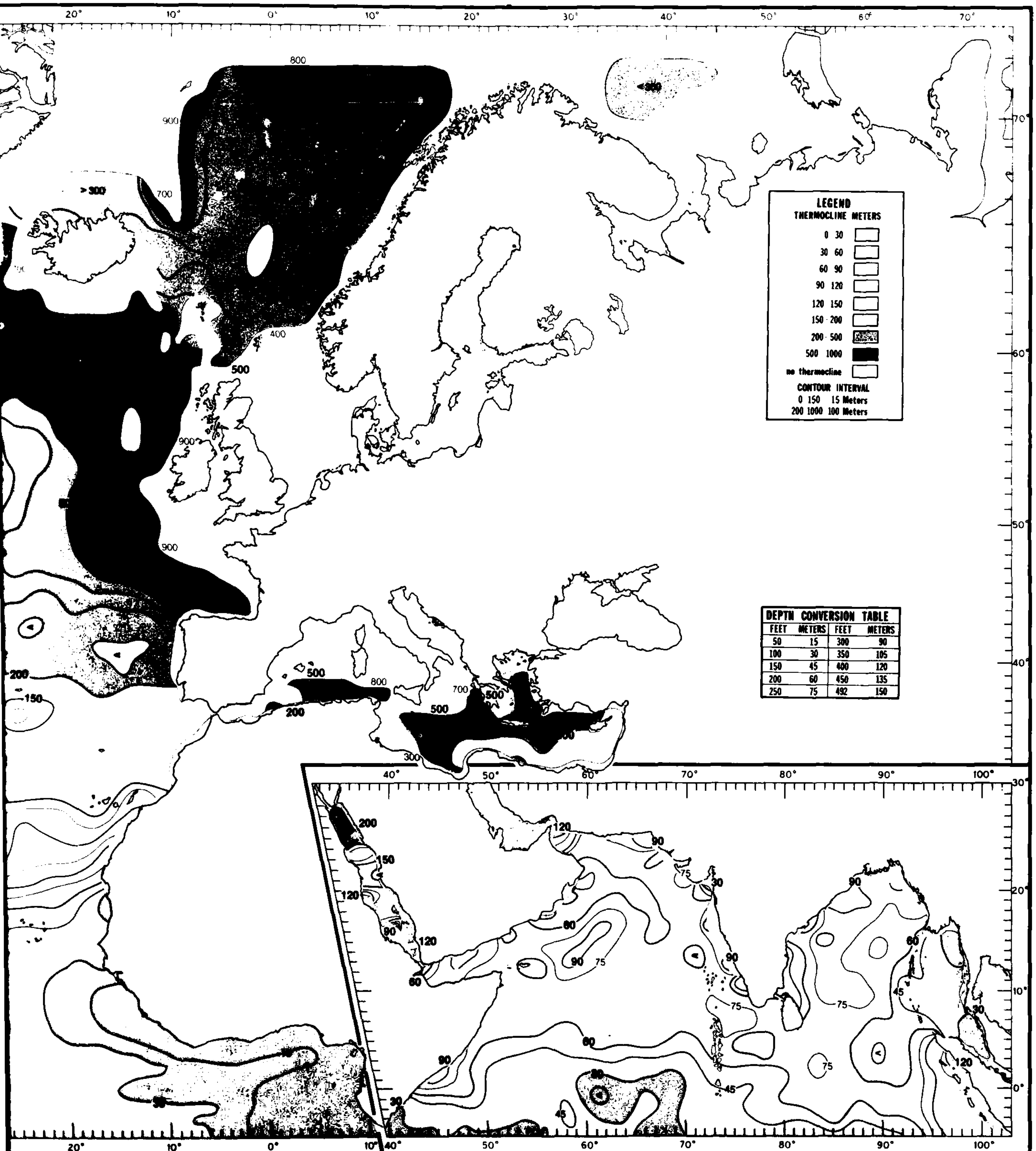


TEMPERATURE DIFFERENCE CONVERSION			
°C	°F	°C	°F
1	1.8	11	19.8
2	3.6	12	21.6
3	5.4	13	23.4
4	7.2	14	25.2
5	9.0	15	27.0
6	10.8	16	28.8
7	12.6	17	30.6
8	14.4	18	32.4
9	16.2	19	34.2
10	18.0	20	35.0

ENCE BETWEEN THE SURFACE AND 400 FT (T_0-T_{400})

2

FIGURE 28. FEBRUARY MEAN DEPTHS TO THE TOP OF THE THERMOCL



DEPTH CONVERSION TABLE			
FEET	METERS	FEET	METERS
50	15	300	90
100	30	350	105
150	45	400	120
200	60	450	135
250	75	492	150

RUARY MEAN DEPTHS TO THE TOP OF THE THERMOCLINE

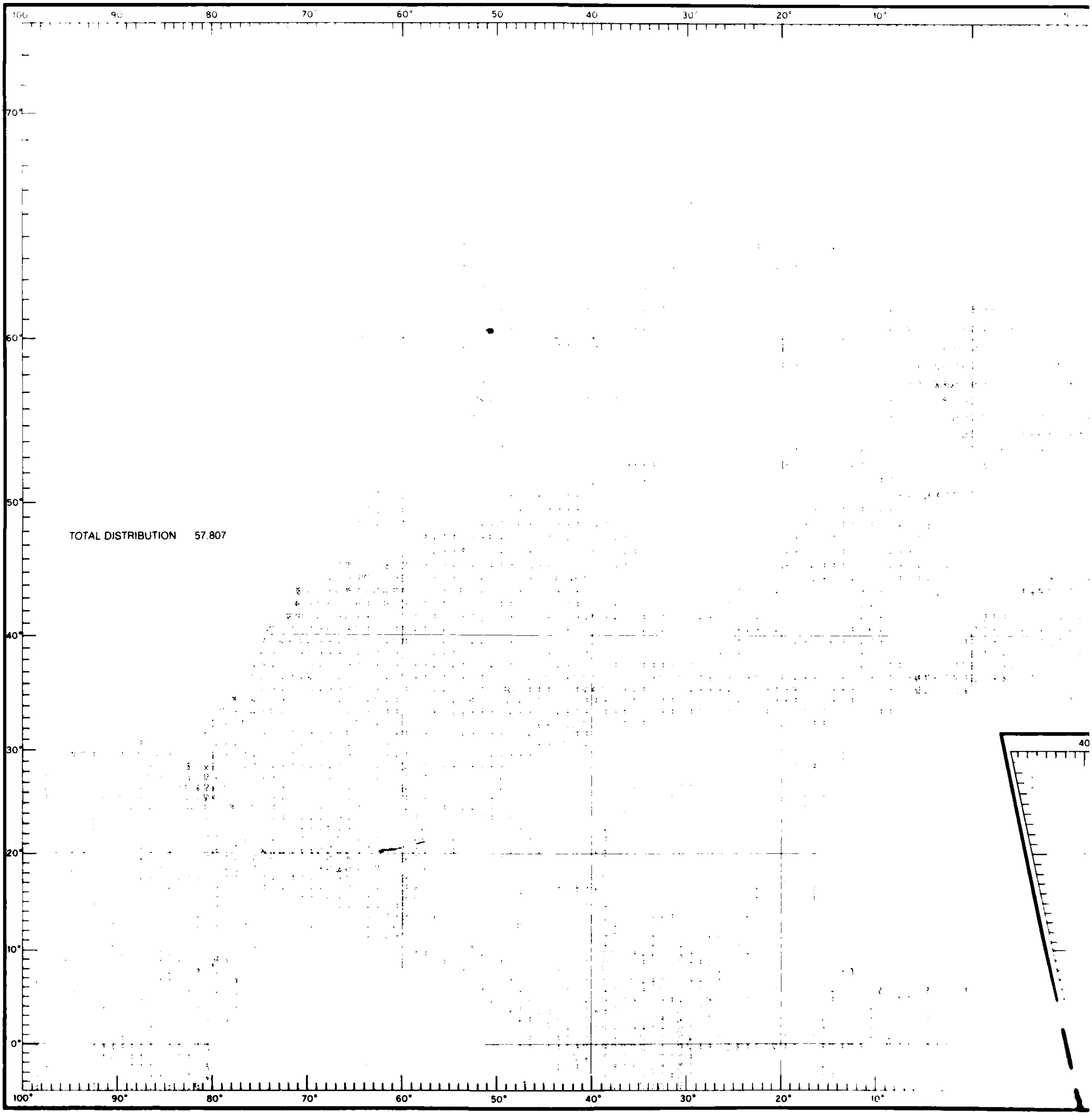
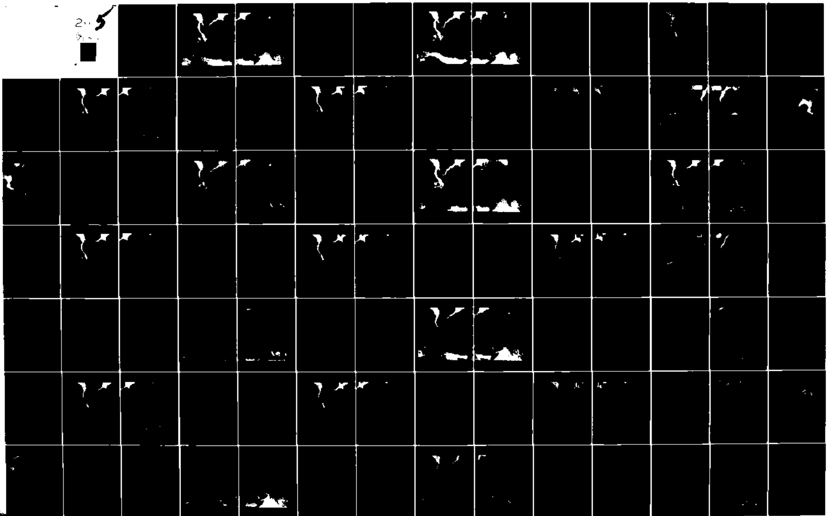
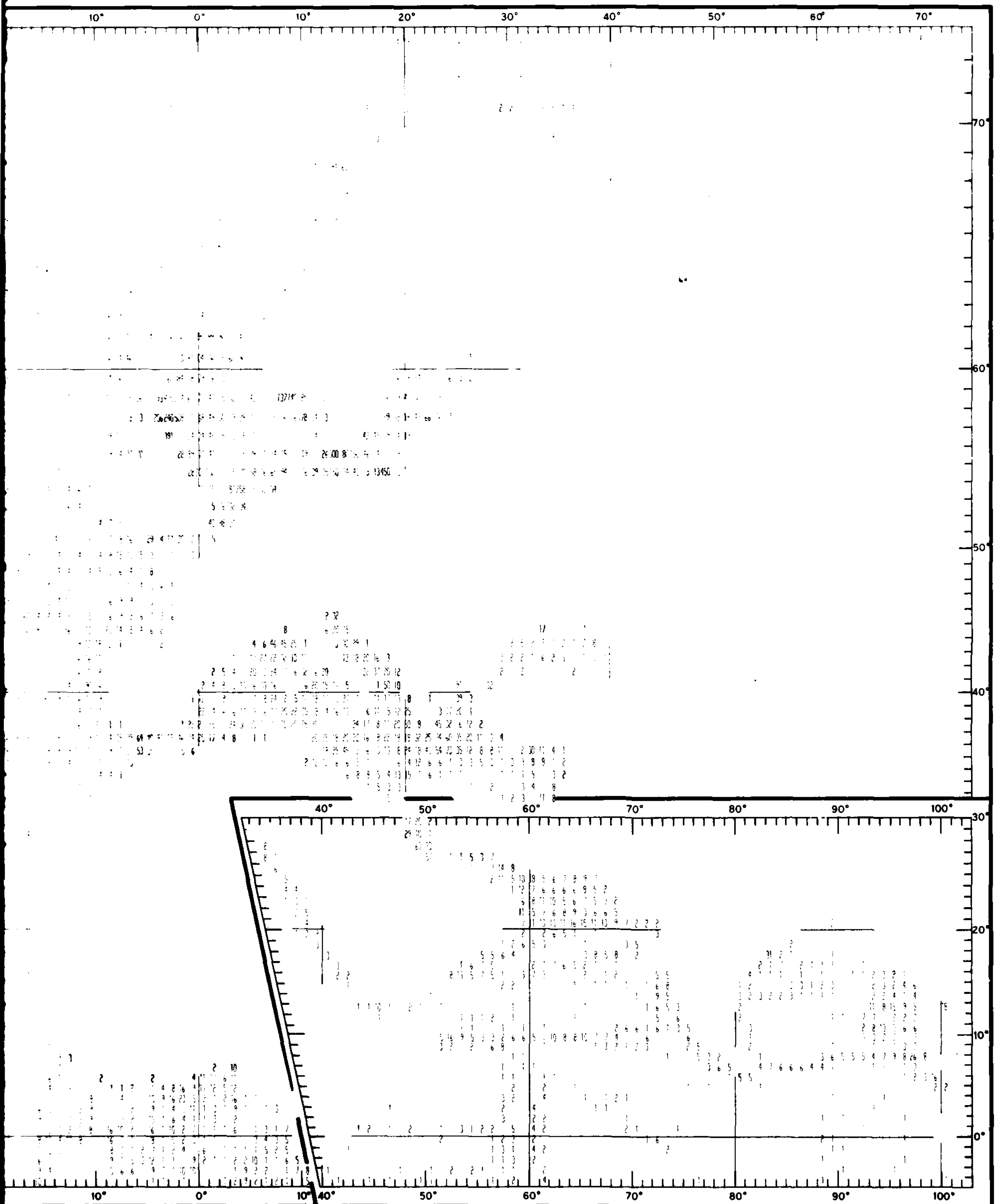


FIGURE 29. MARCH DATA DISTRIBUTION OF TEMPERAT

D-A087 571 NAVAL OCEANOGRAPHIC OFFICE NSTL STATION MS F/G 8/10
ATLAS OF NORTH ATLANTIC-INDIAN OCEAN MONTHLY MEAN TEMPERATURES --ETC
1979 M K ROBINSON, R A BAUER, E H SCHROEDER
UNCLASSIFIED NOO-RP-18 NL

2 of 5





UTION OF TEMPERATURES AT THE SURFACE

1

2

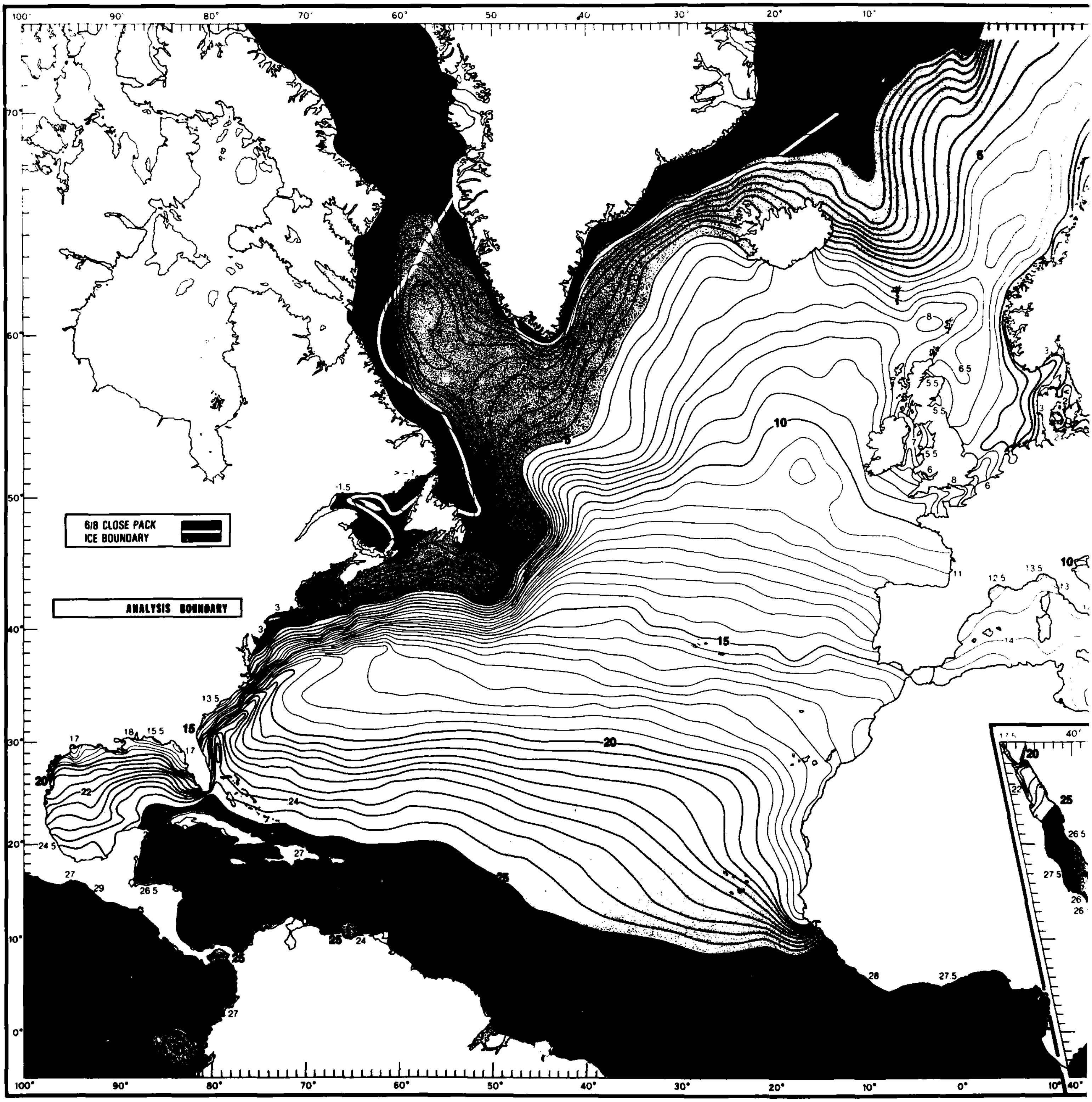
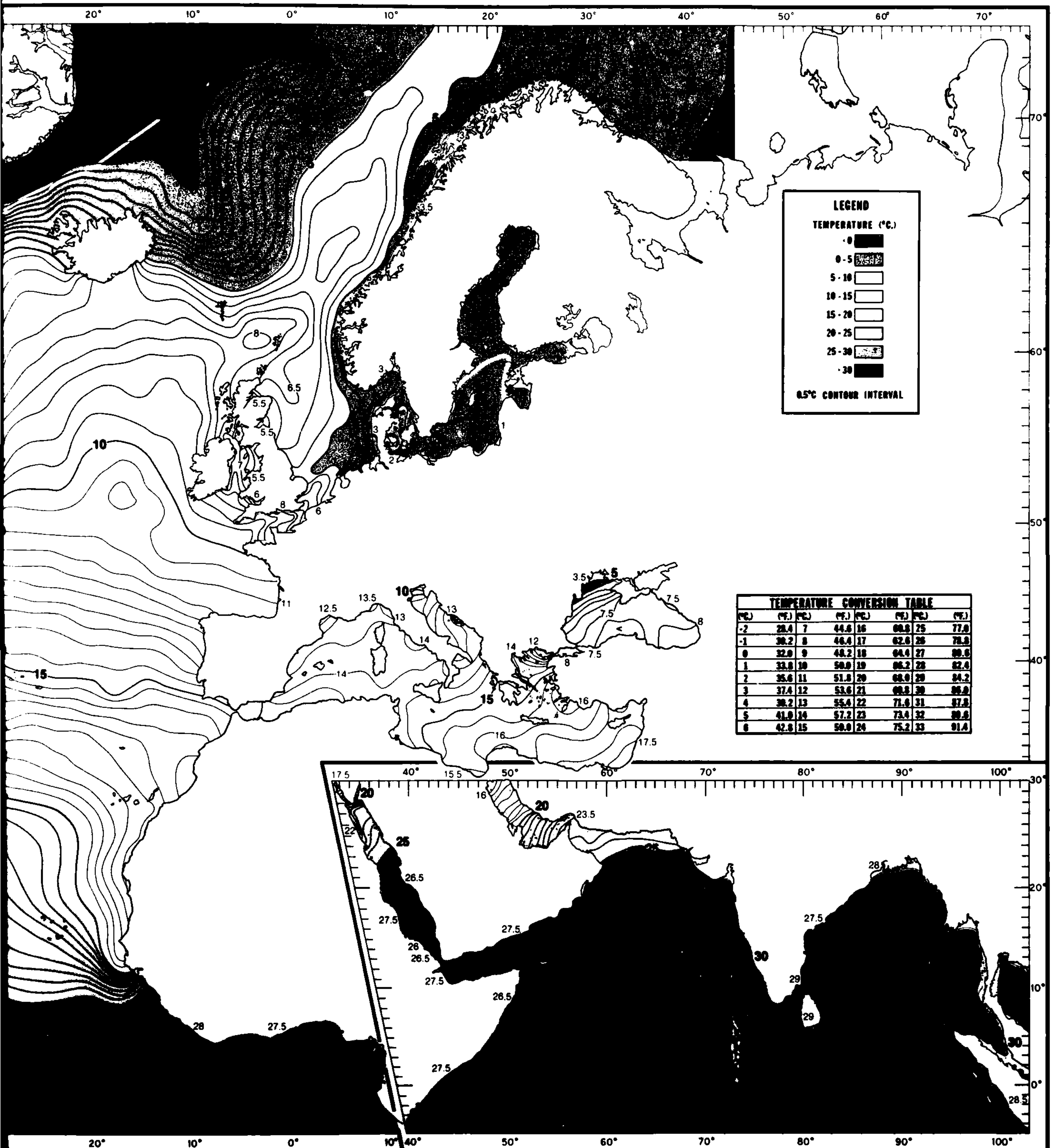


FIGURE 30. MARCH MEAN TEMPERATURES AT THE SURFACE



TEMPERATURE CONVERSION TABLE							
(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

MARCH MEAN TEMPERATURES AT THE SURFACE

1 2

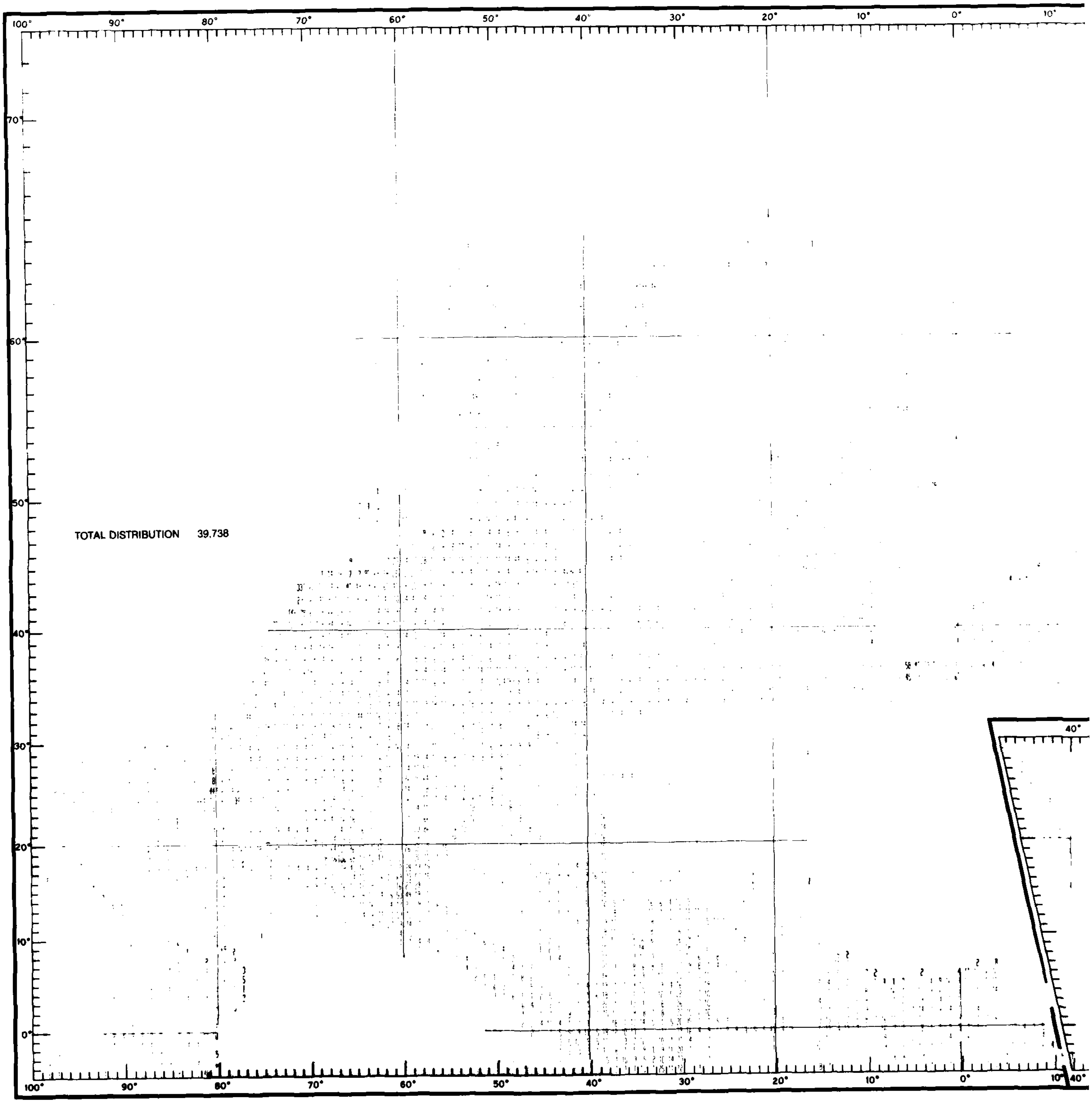
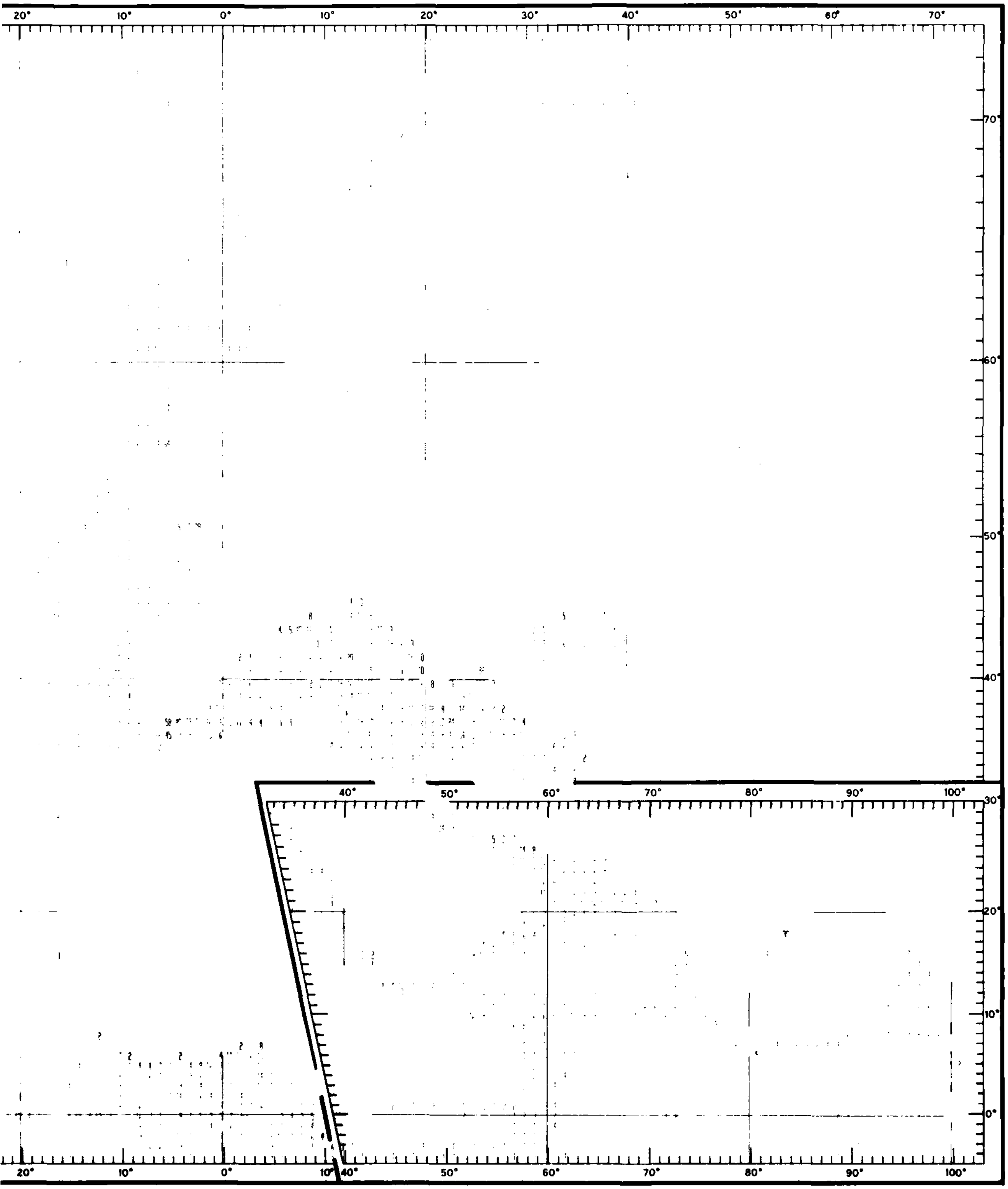


FIGURE 31. MARCH DATA DISTRIBUTION OF TEMPERATURES AT 100 FT (30 M



STRIBUTION OF TEMPERATURES AT 100 FT (30 M)

1

2

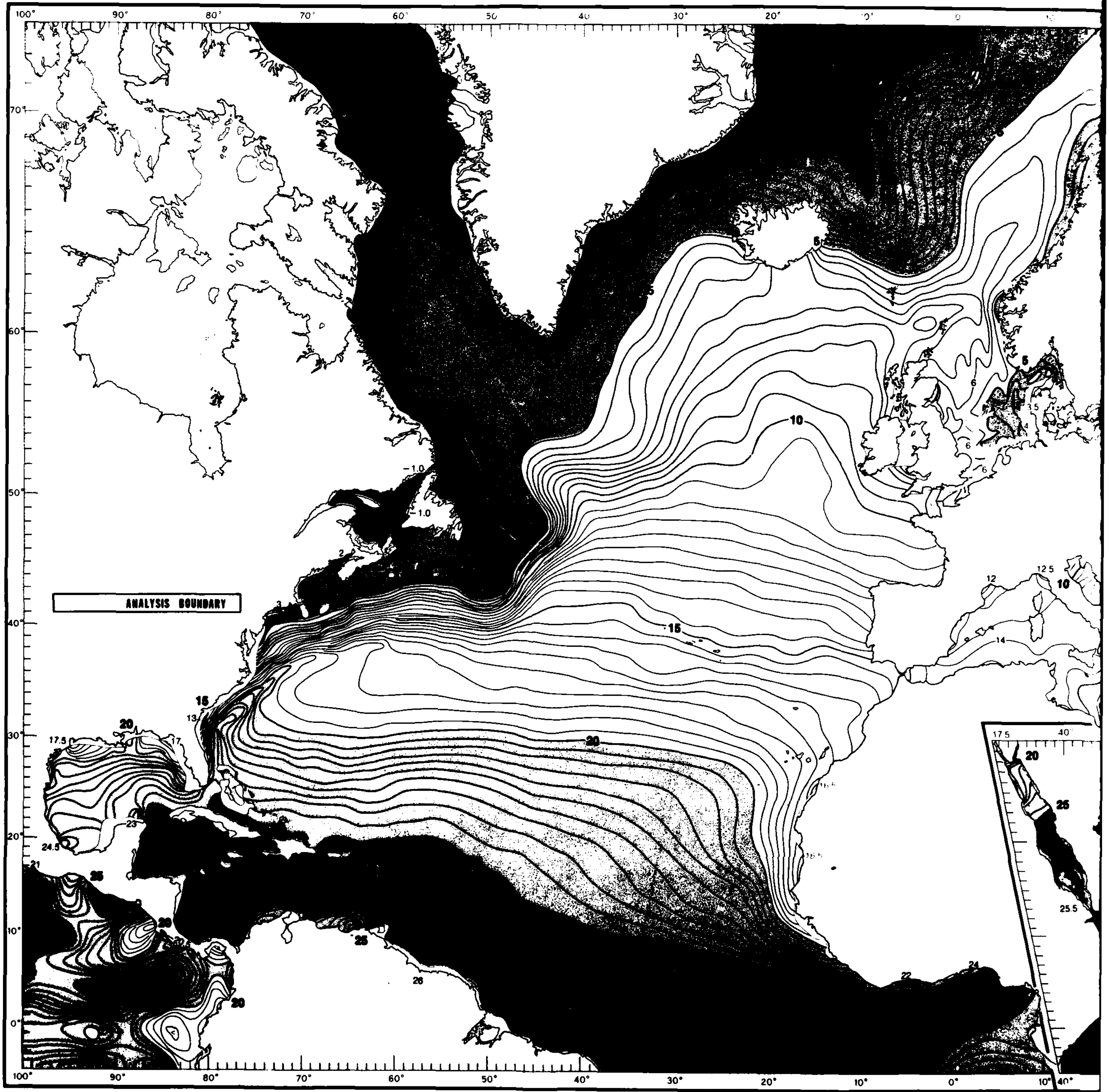
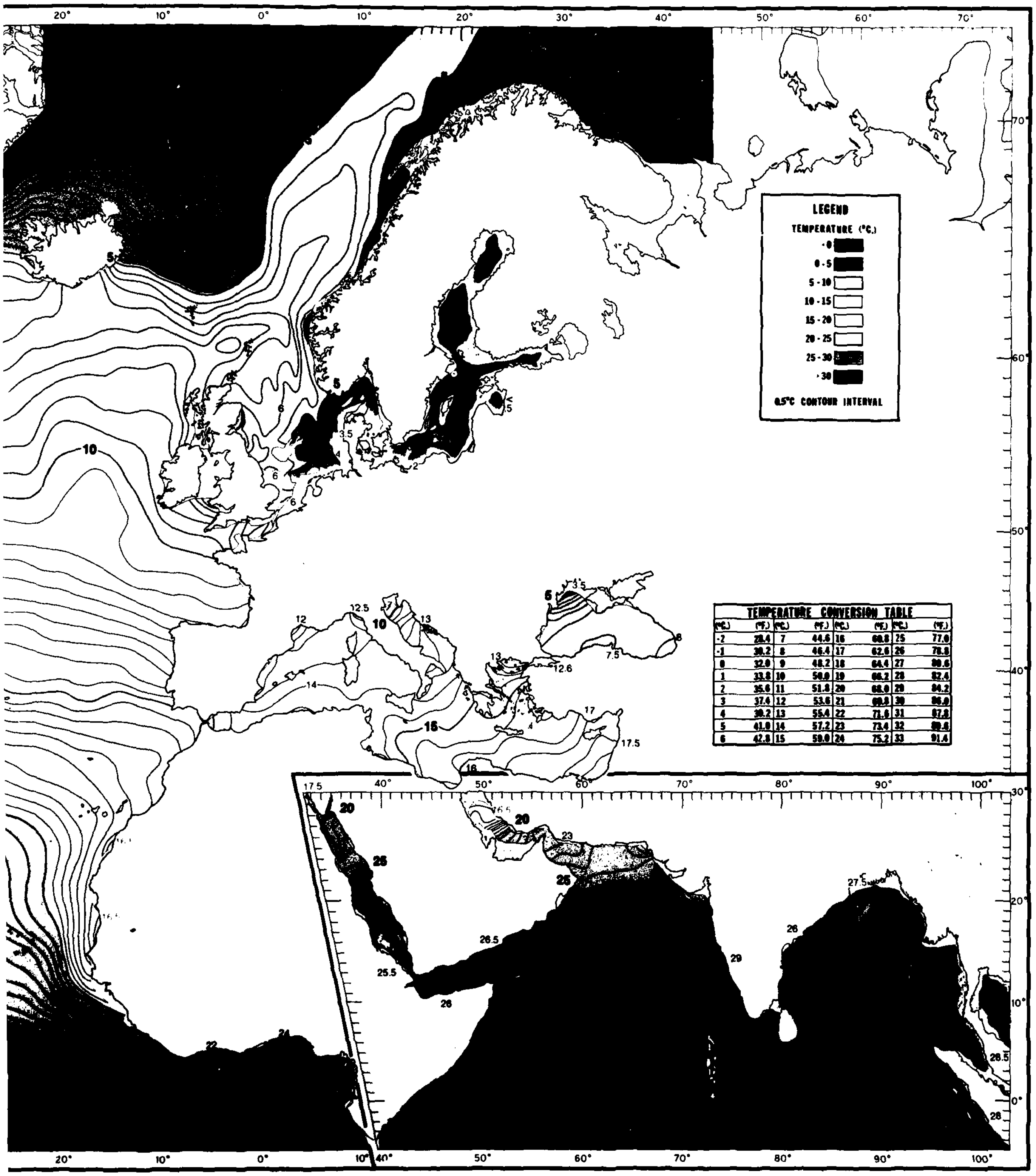


FIGURE 32. MARCH MEAN TEMPERATURES AT 100 FT (30 M)

1



TEMPERATURE CONVERSION TABLE							
(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

CH MEAN TEMPERATURES AT 100 FT (30 M)

1 2

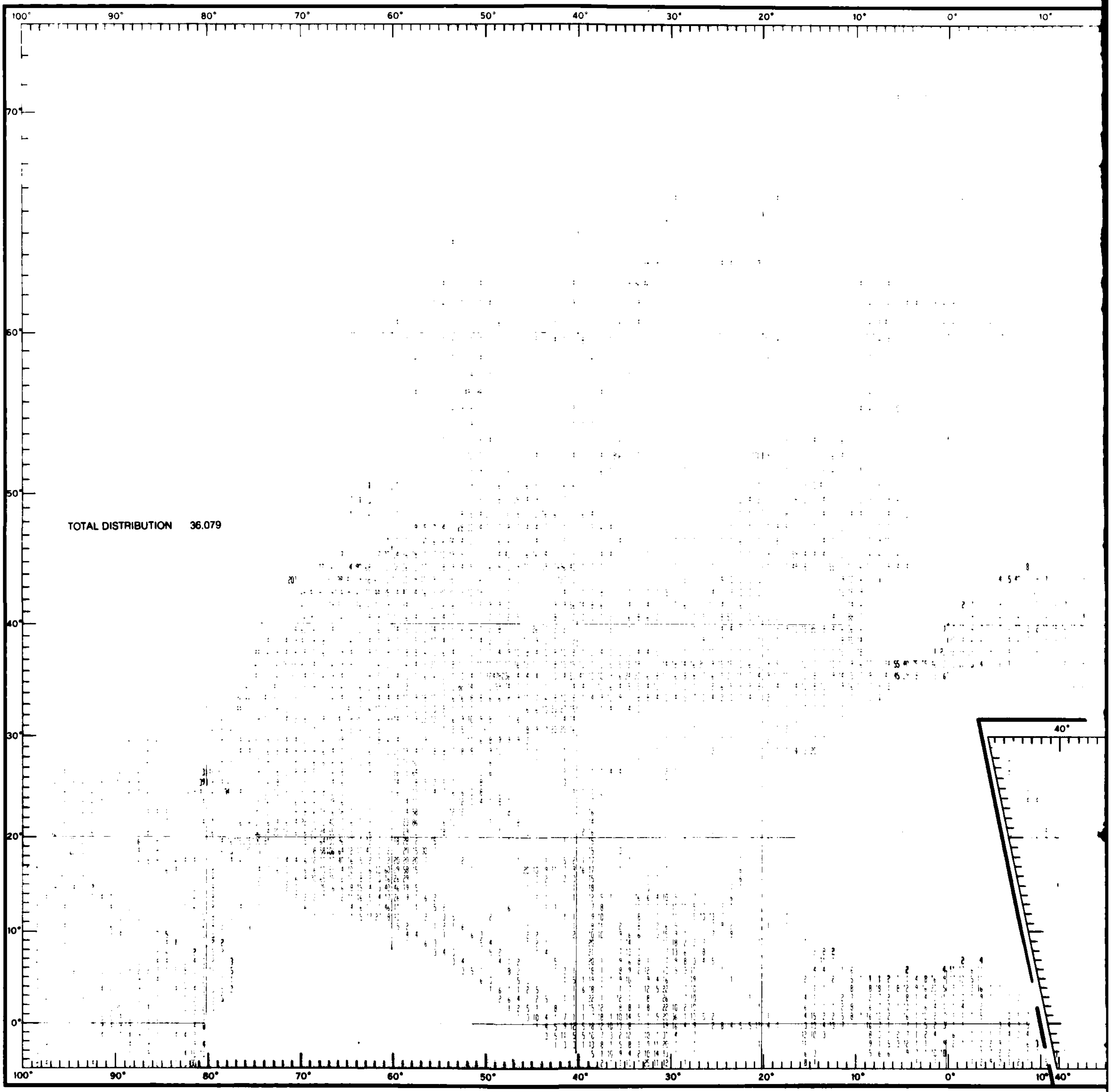
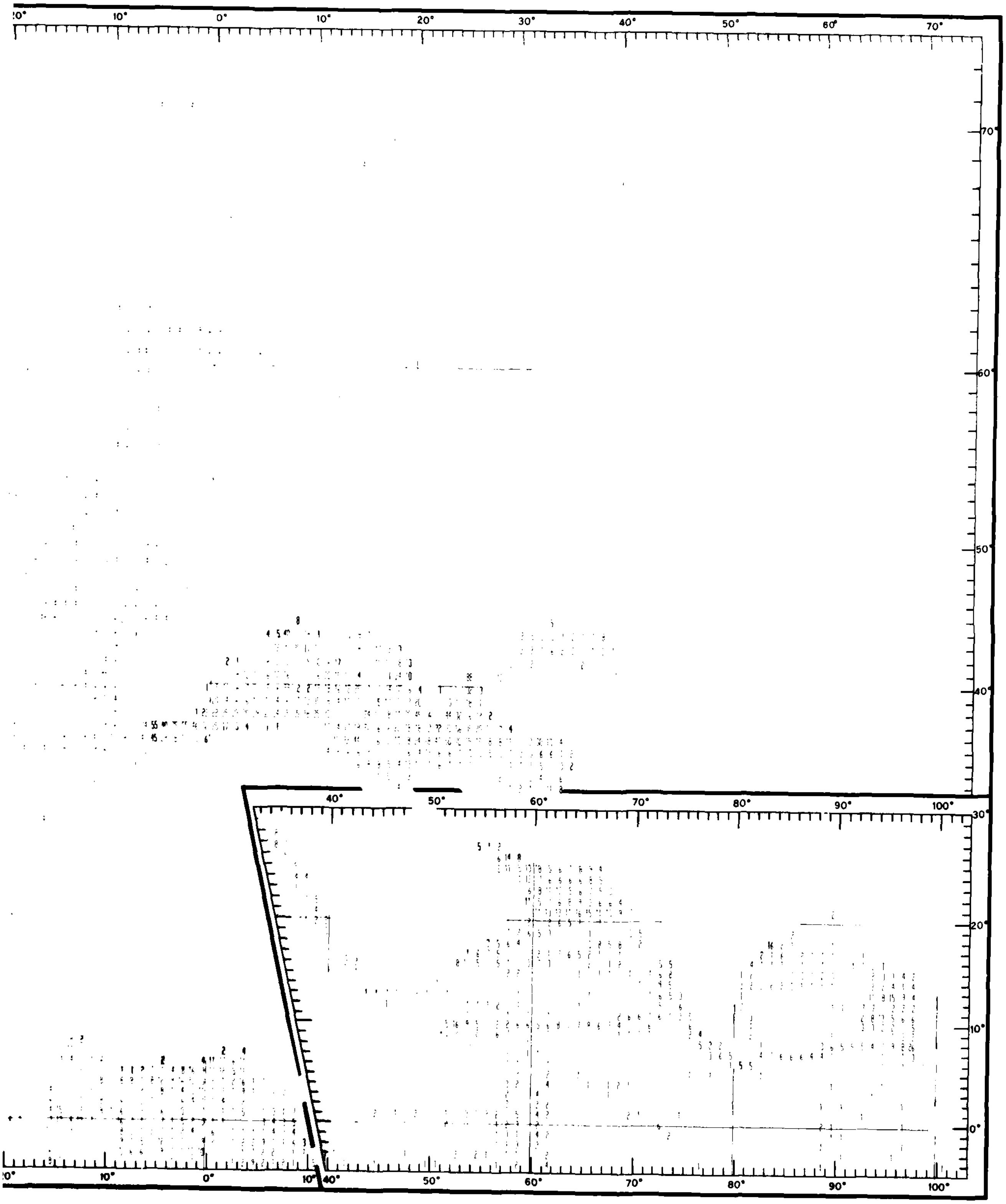


FIGURE 33. MARCH DATA DISTRIBUTION OF TEMPERATURES AT 200 FT (60 M)

1



TRIBUTION OF TEMPERATURES AT 200 FT (60 M)

2

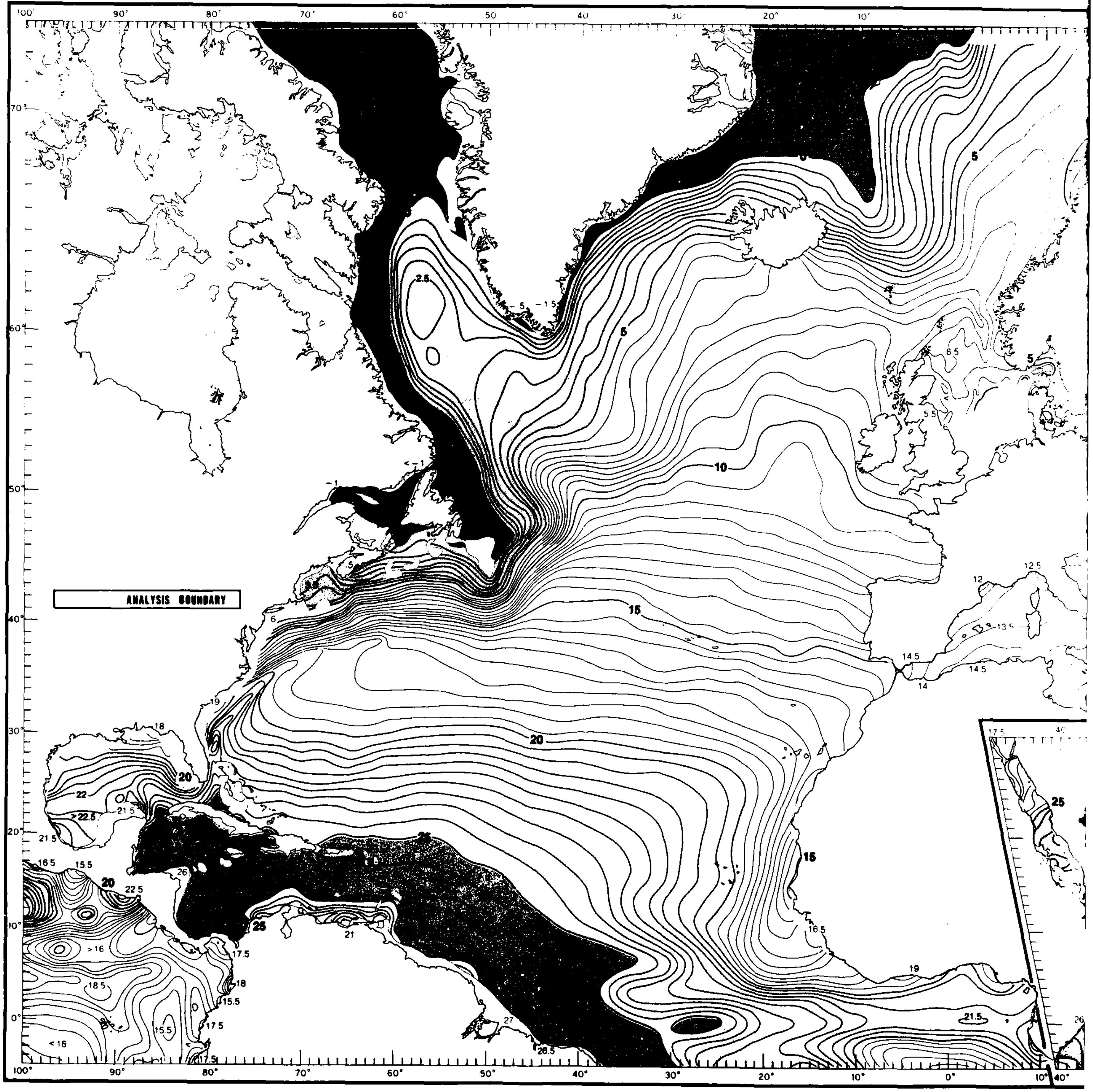
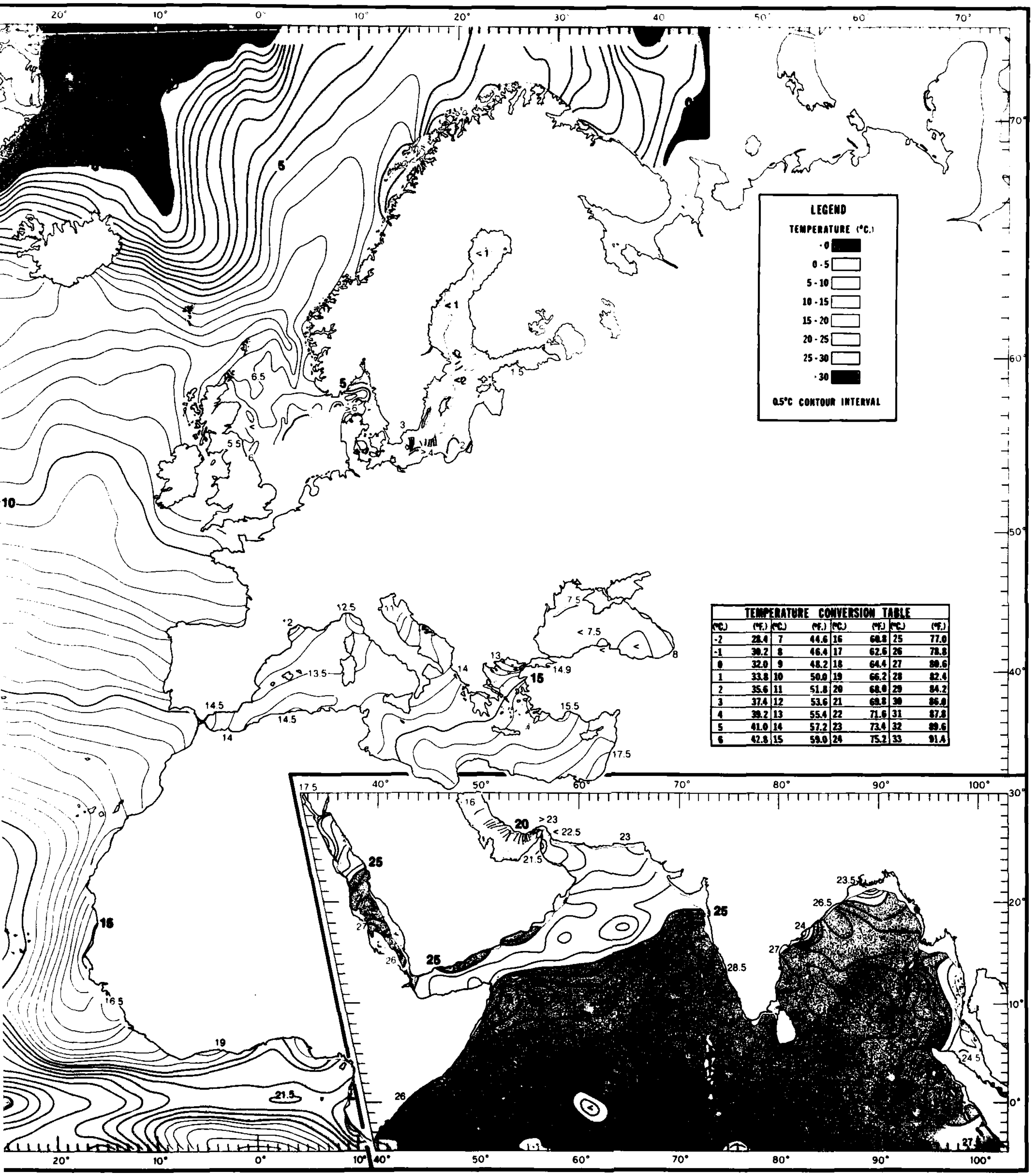


FIGURE 34. MARCH MEAN TEMPERATURES AT 200 FT (60 M)

1



TEMPERATURE CONVERSION TABLE							
(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

RCH MEAN TEMPERATURES AT 200 FT (60 M)

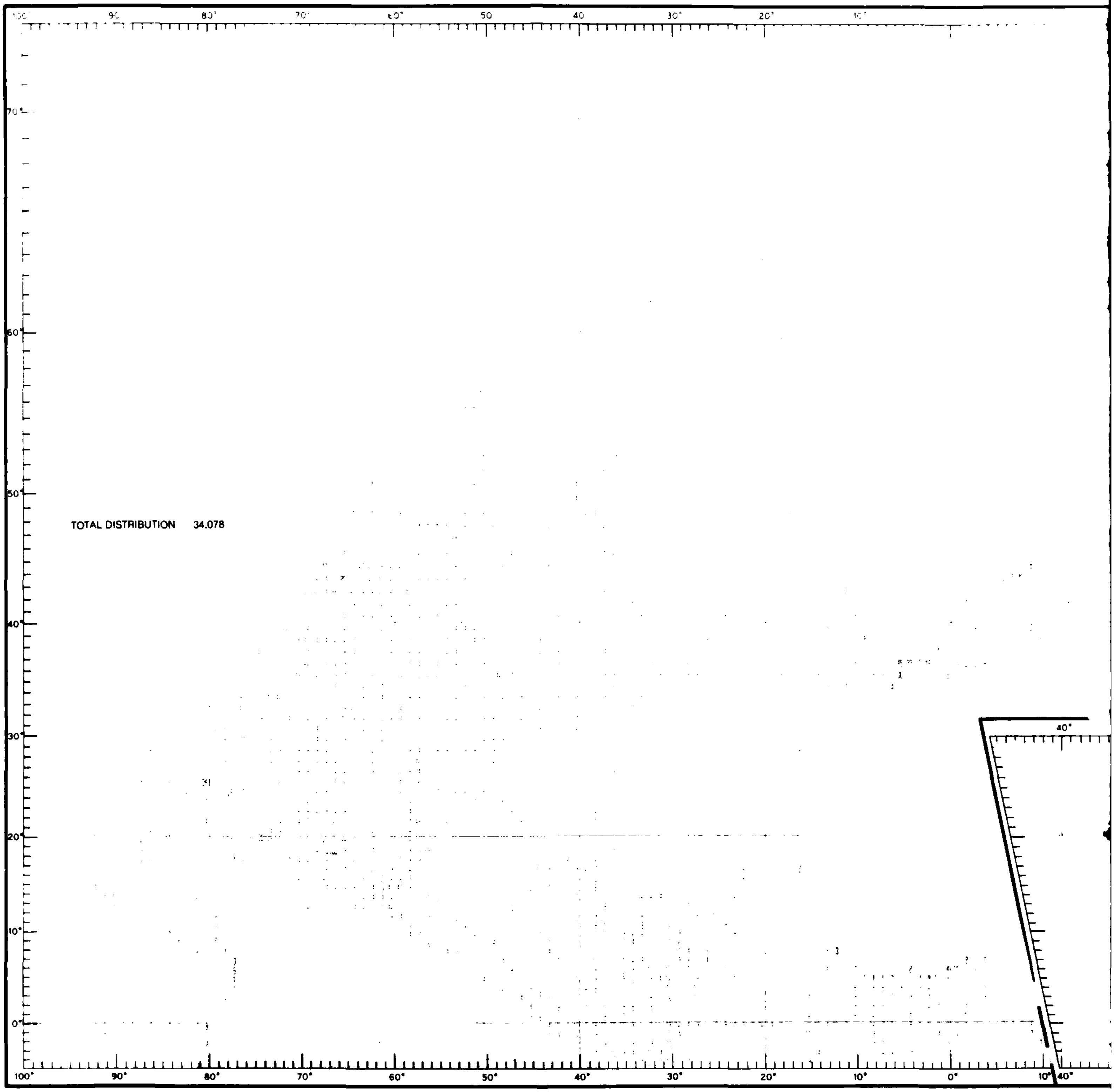
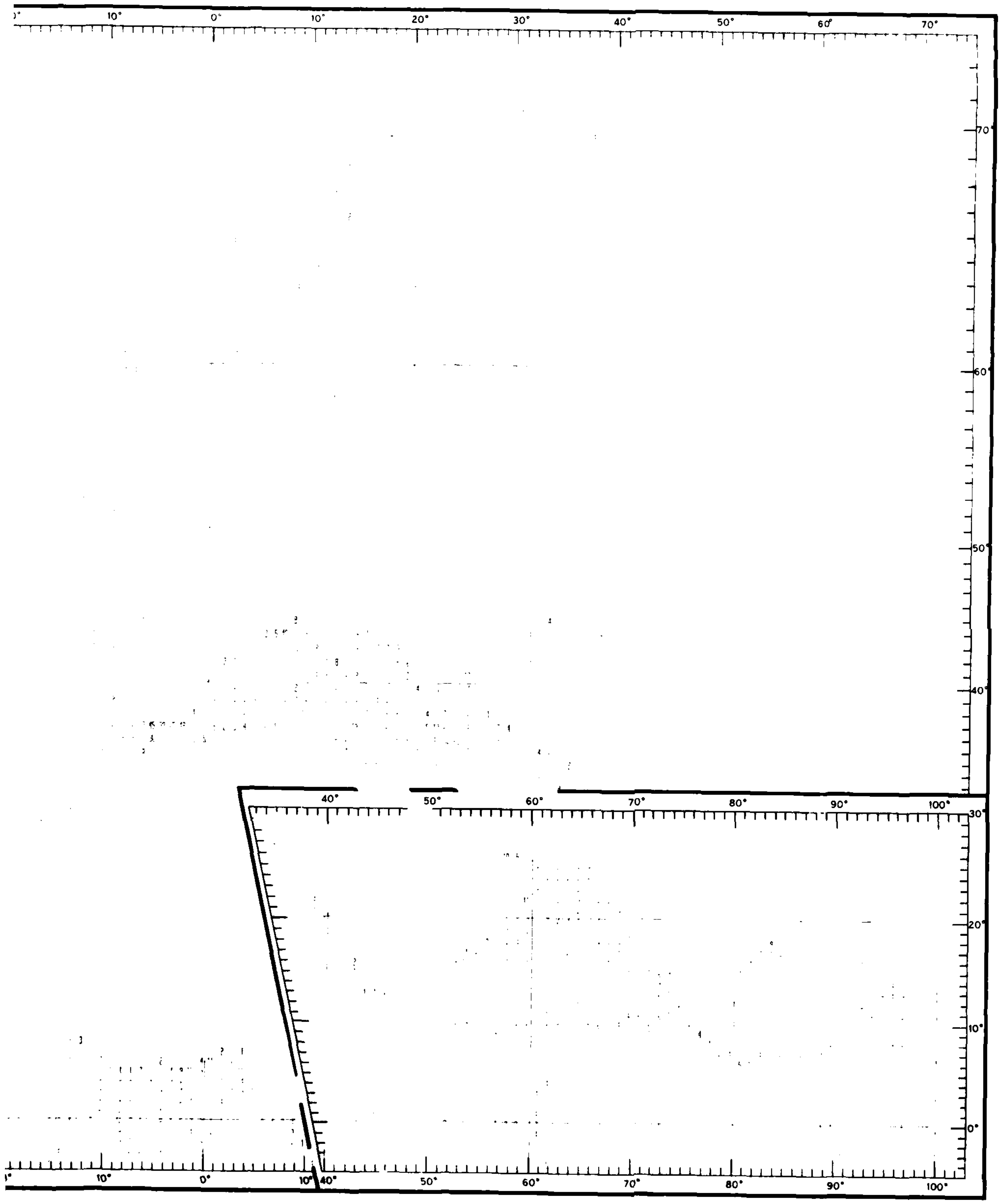


FIGURE 35. MARCH DATA DISTRIBUTION OF TEMPERATURES AT 300 FT (90 M)



RIBUTION OF TEMPERATURES AT 300 FT (90 M)

2

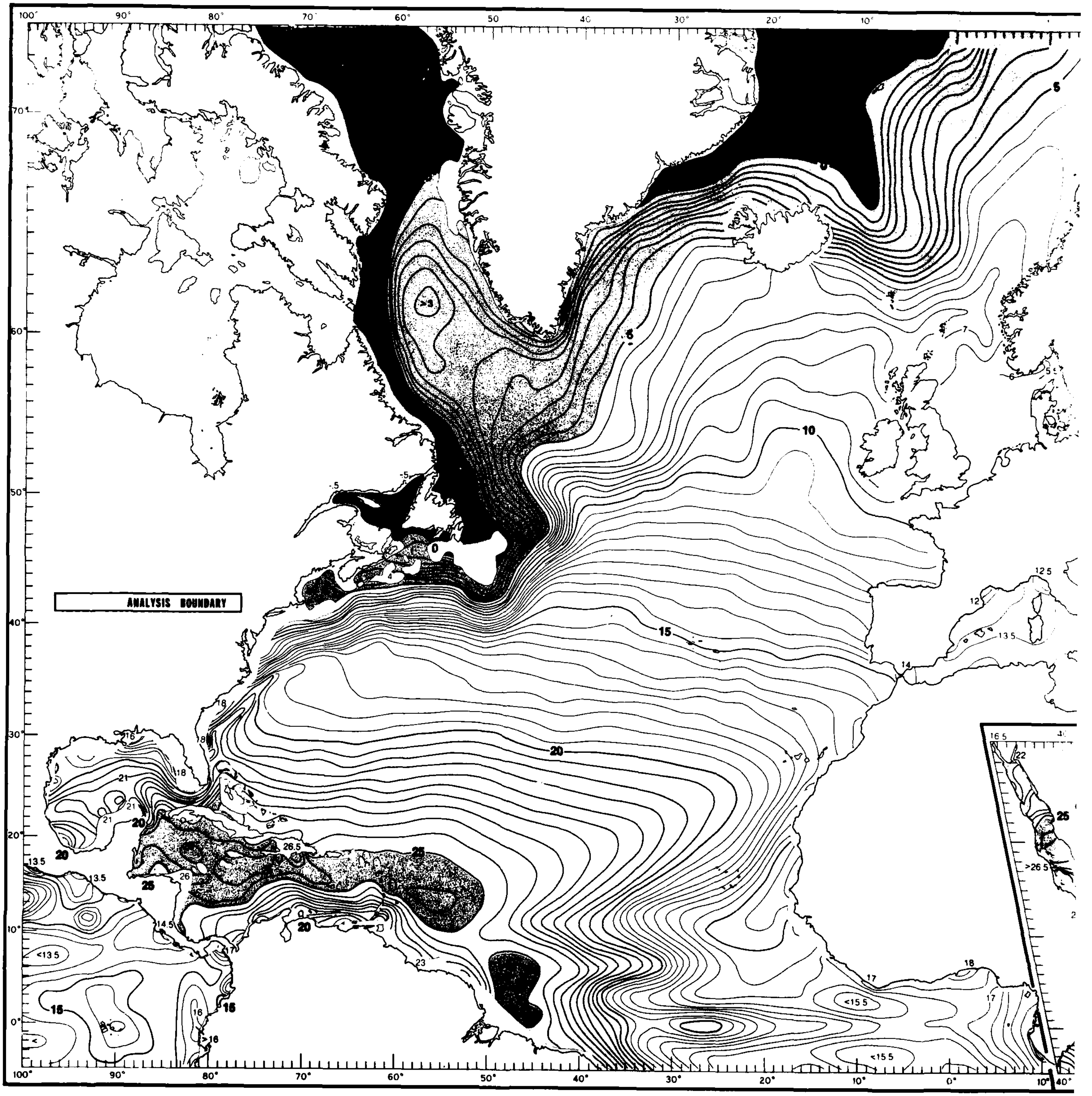
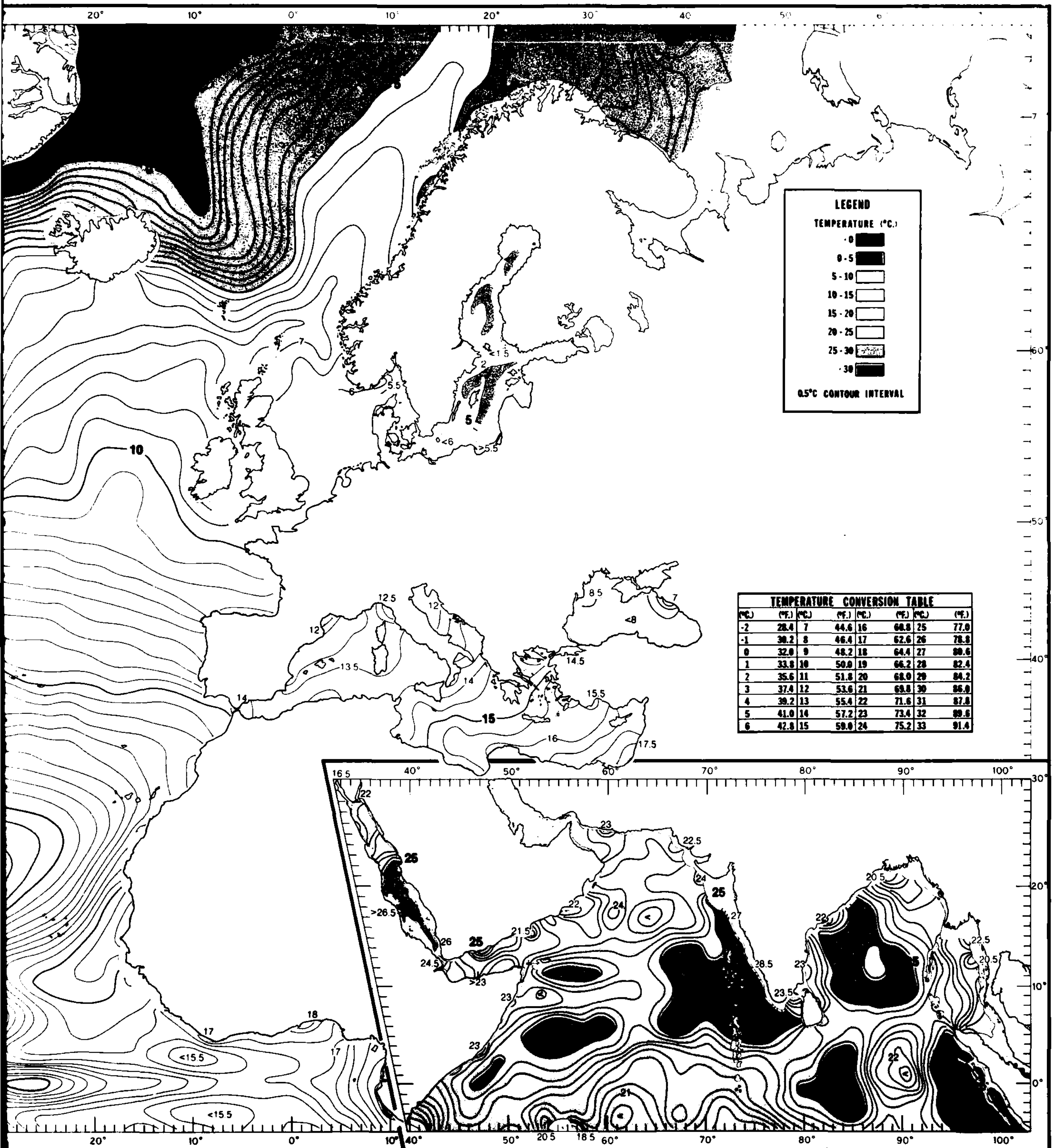


FIGURE 36. MARCH MEAN TEMPERATURES AT 300 FT (90 M)

1



TEMPERATURE CONVERSION TABLE

(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

. MARCH MEAN TEMPERATURES AT 300 FT (90 M)

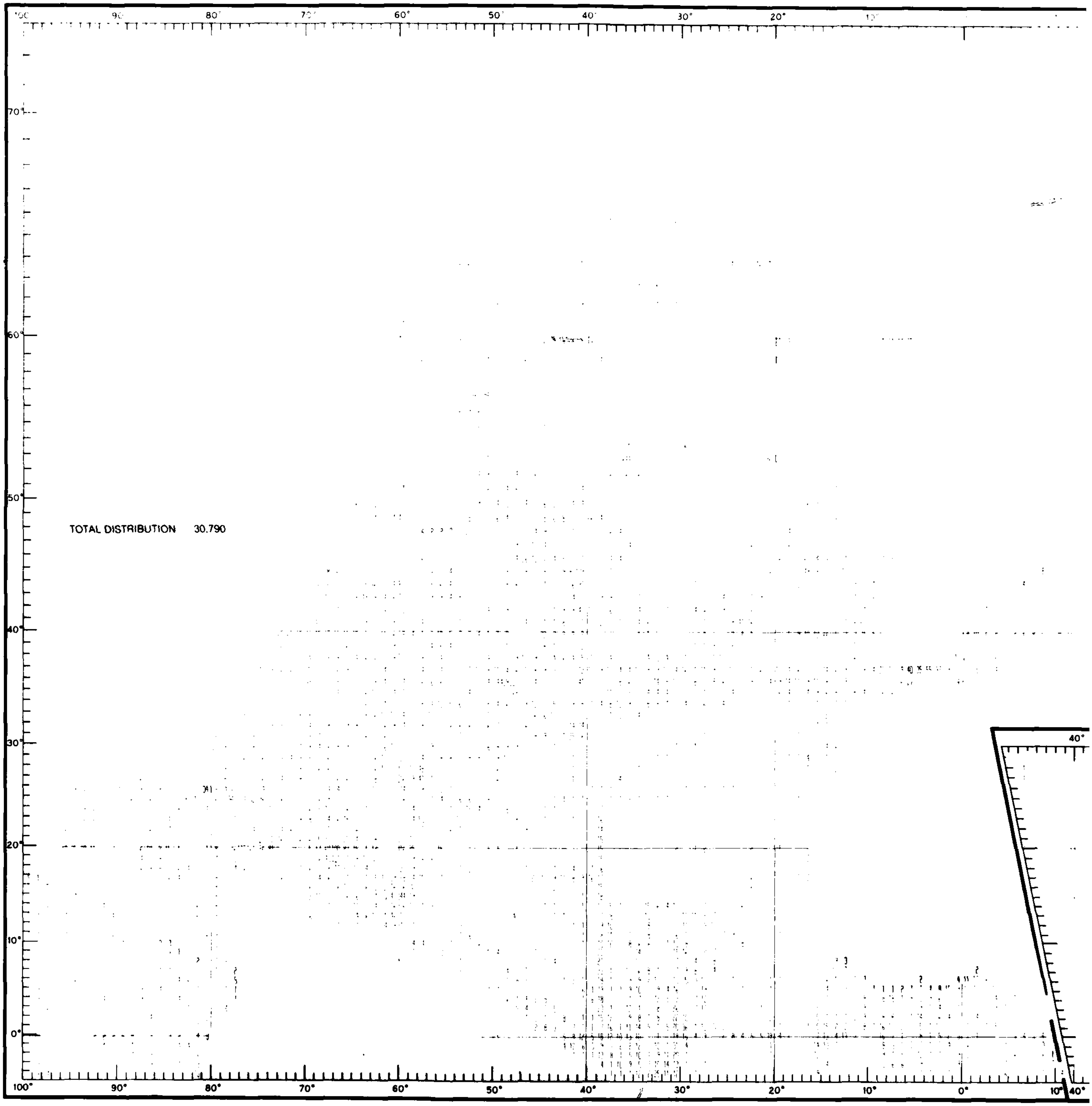
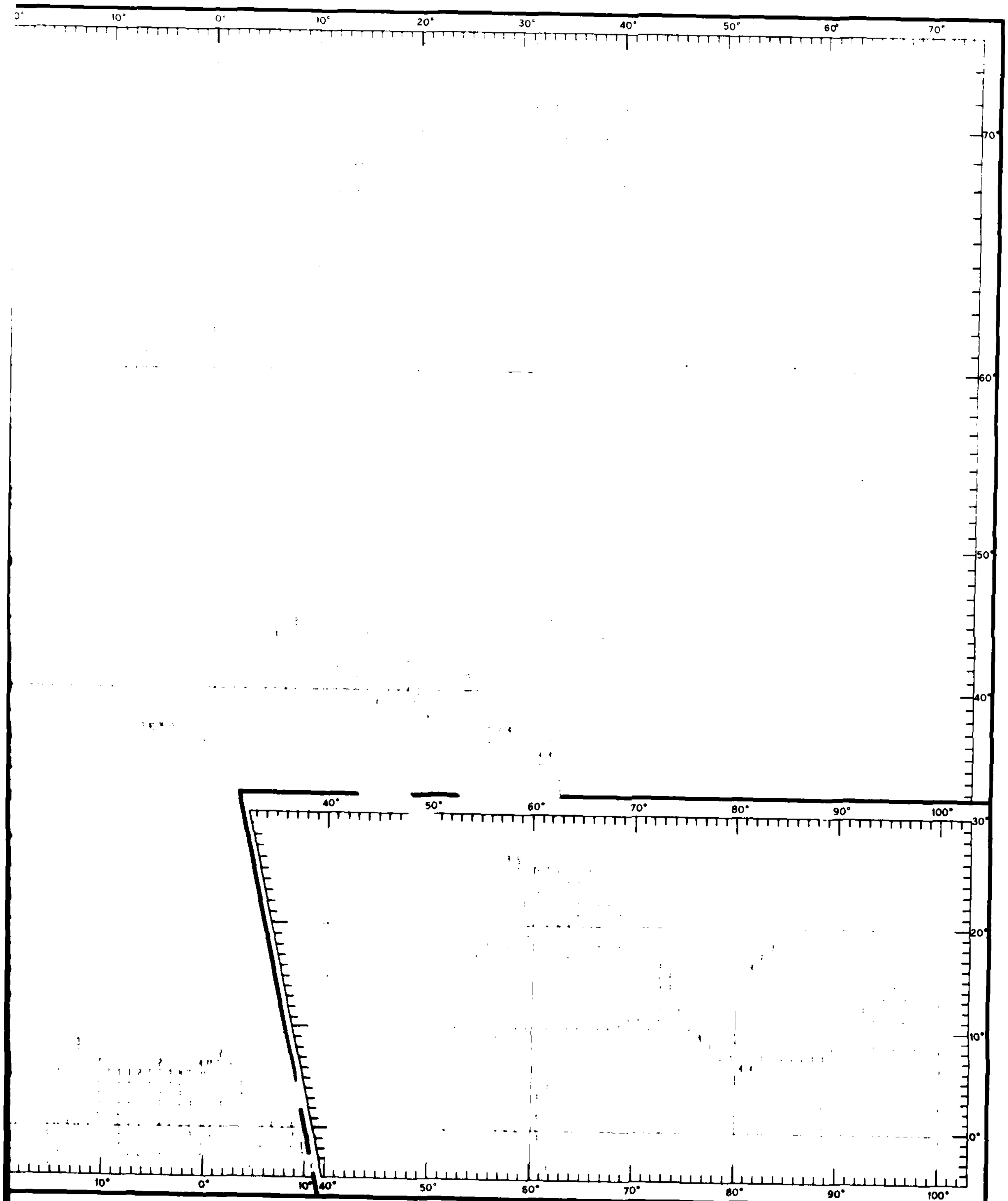


FIGURE 37. MARCH DATA DISTRIBUTION OF TEMPERATURES AT 400 FT (120



IBUTION OF TEMPERATURES AT 400 FT (120 M)

2

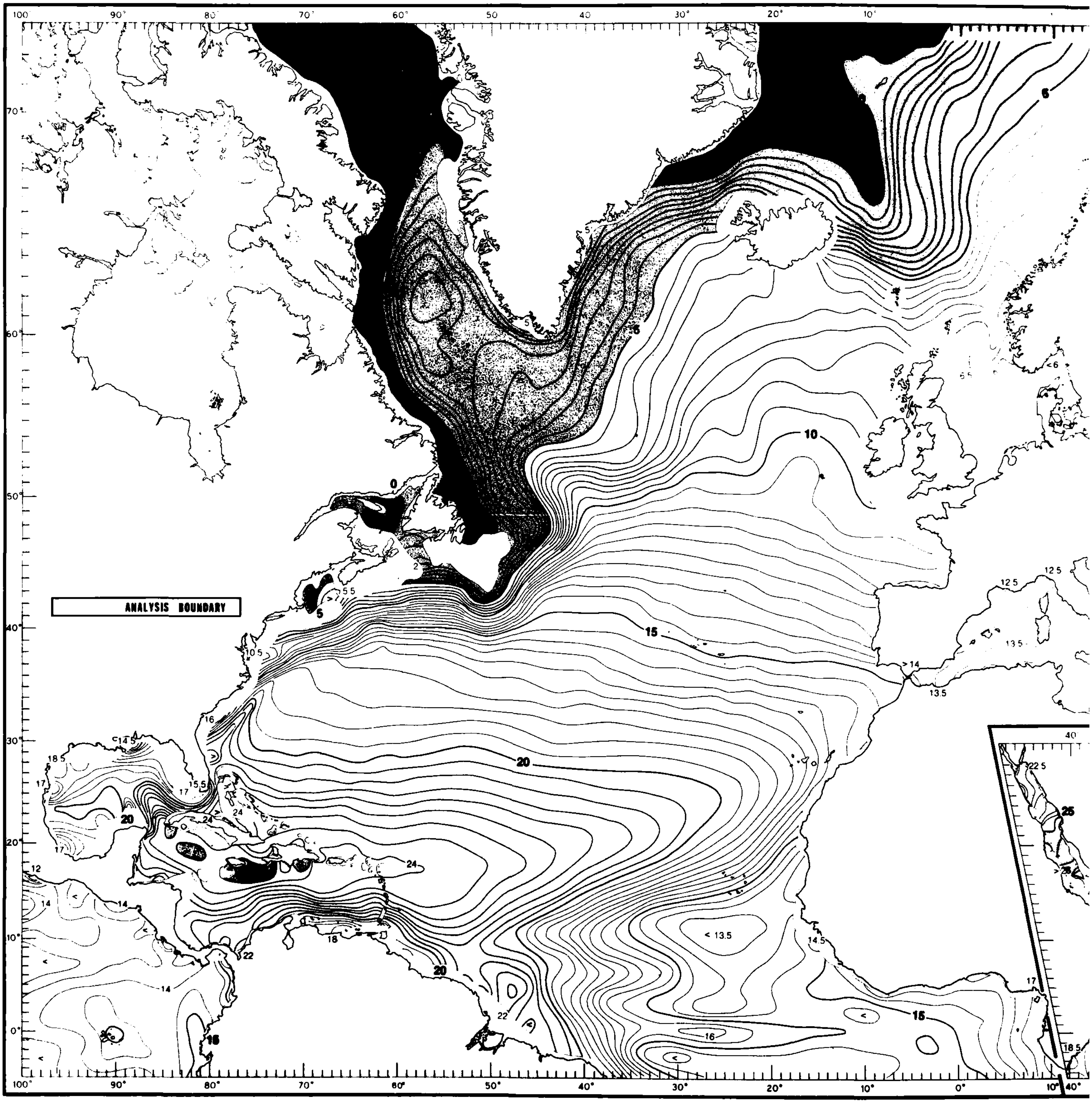
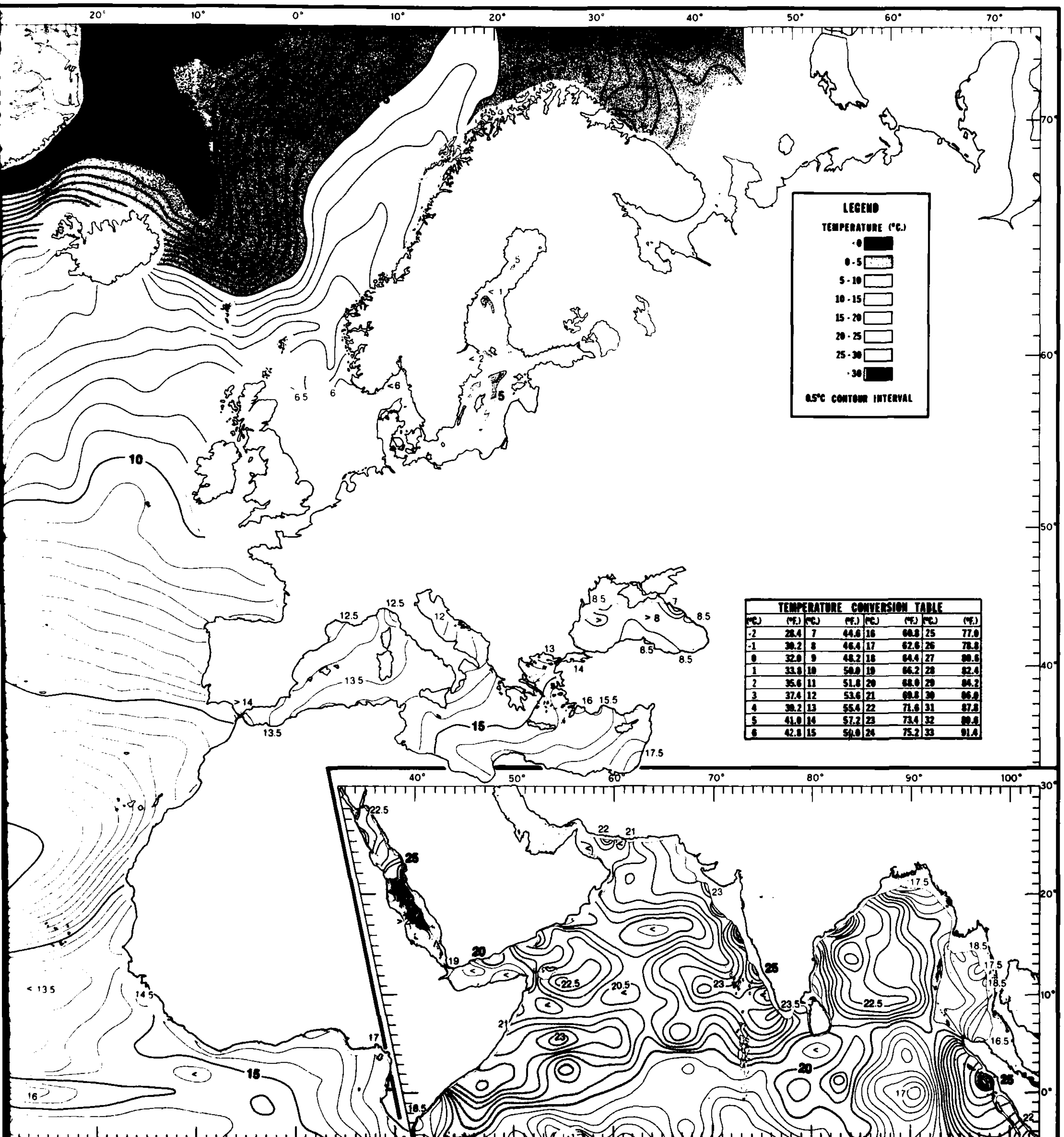


FIGURE 38. MARCH MEAN TEMPERATURES AT 400 FT (120 M)



TEMPERATURE CONVERSION TABLE							
(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

E 38. MARCH MEAN TEMPERATURES AT 400 FT (120 M)

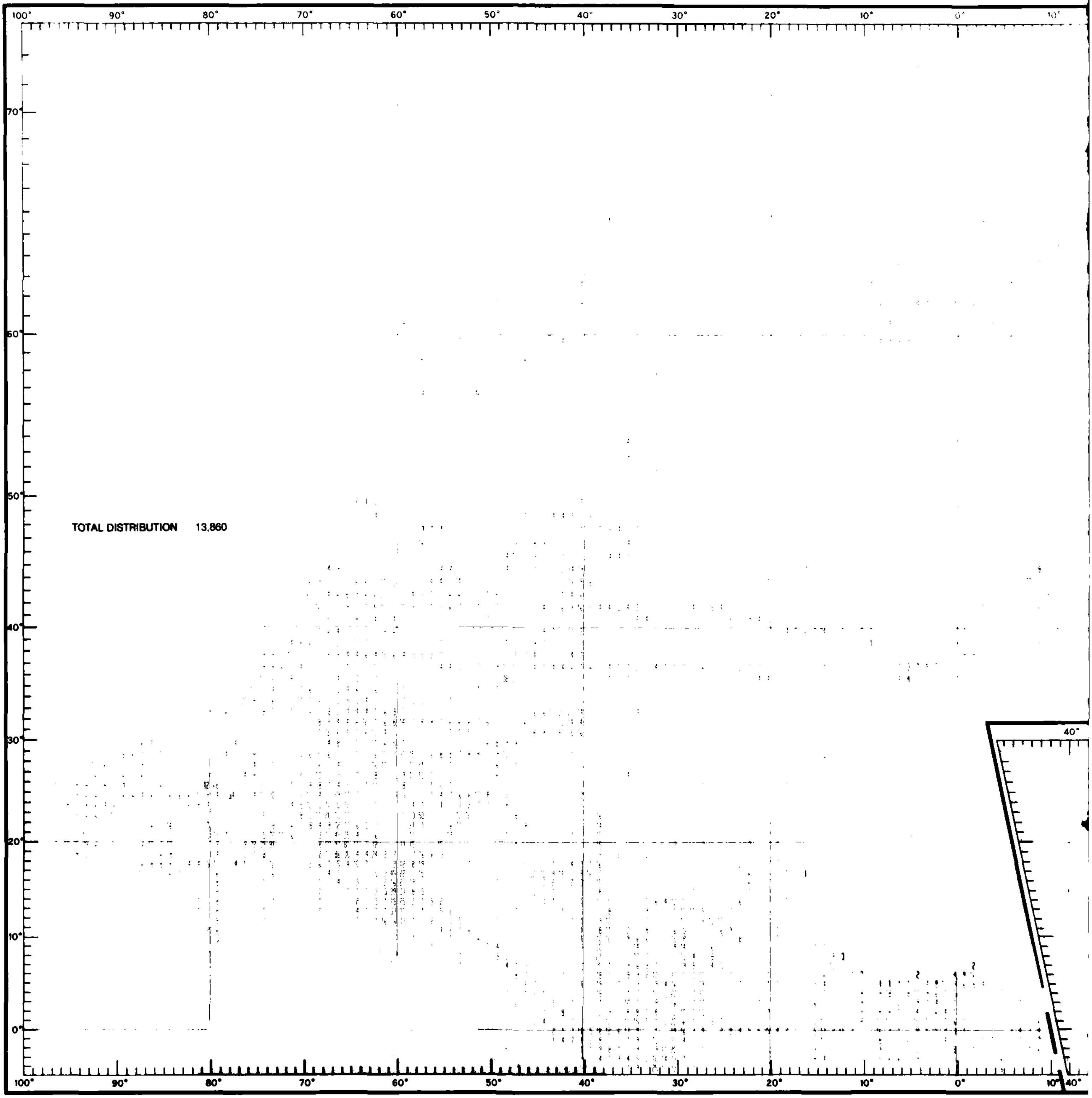
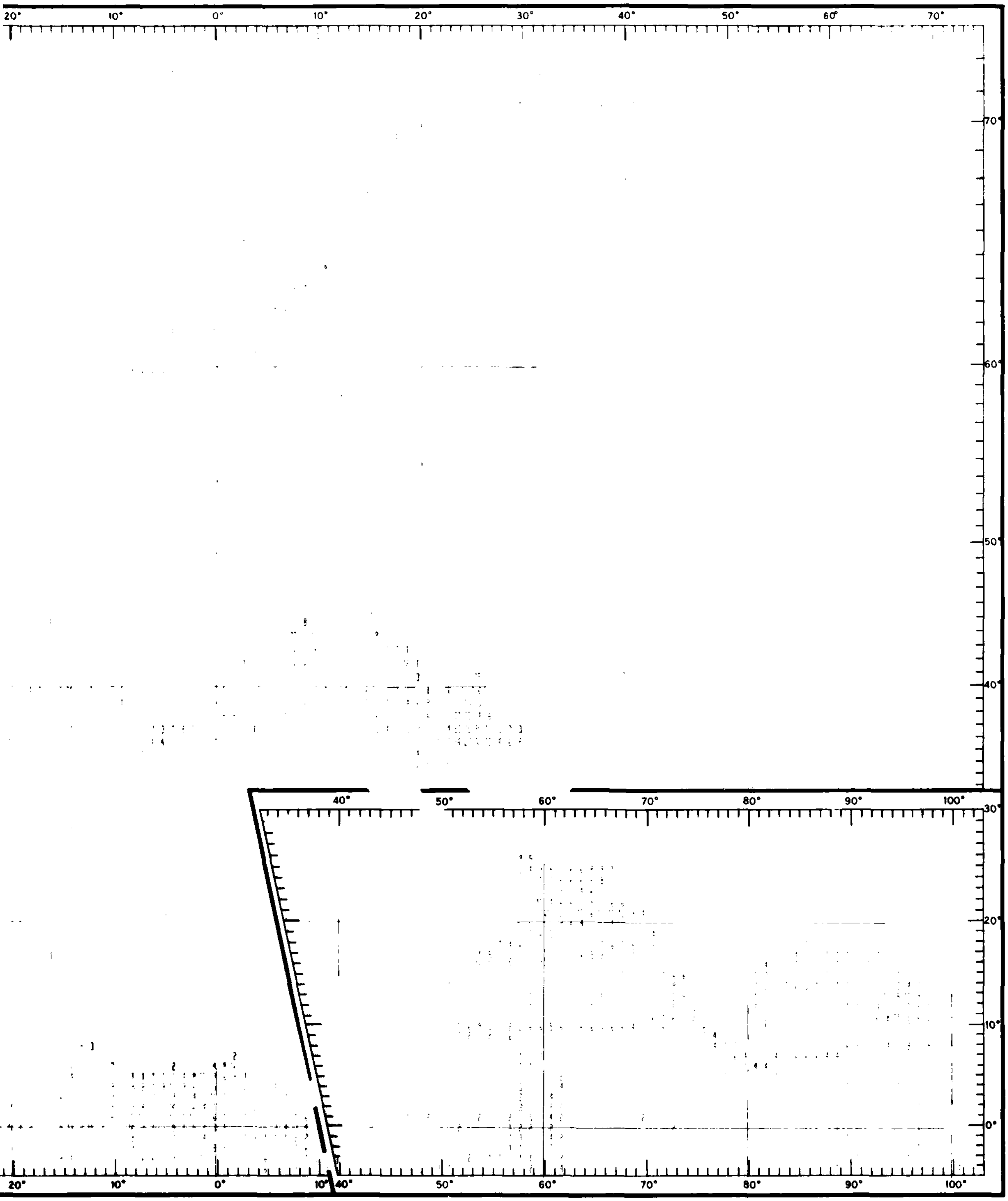


FIGURE 39. MARCH DATA DISTRIBUTION OF TEMPERATURES AT 492 FT (150

1



STRIBUTION OF TEMPERATURES AT 492 FT (150 M)

2

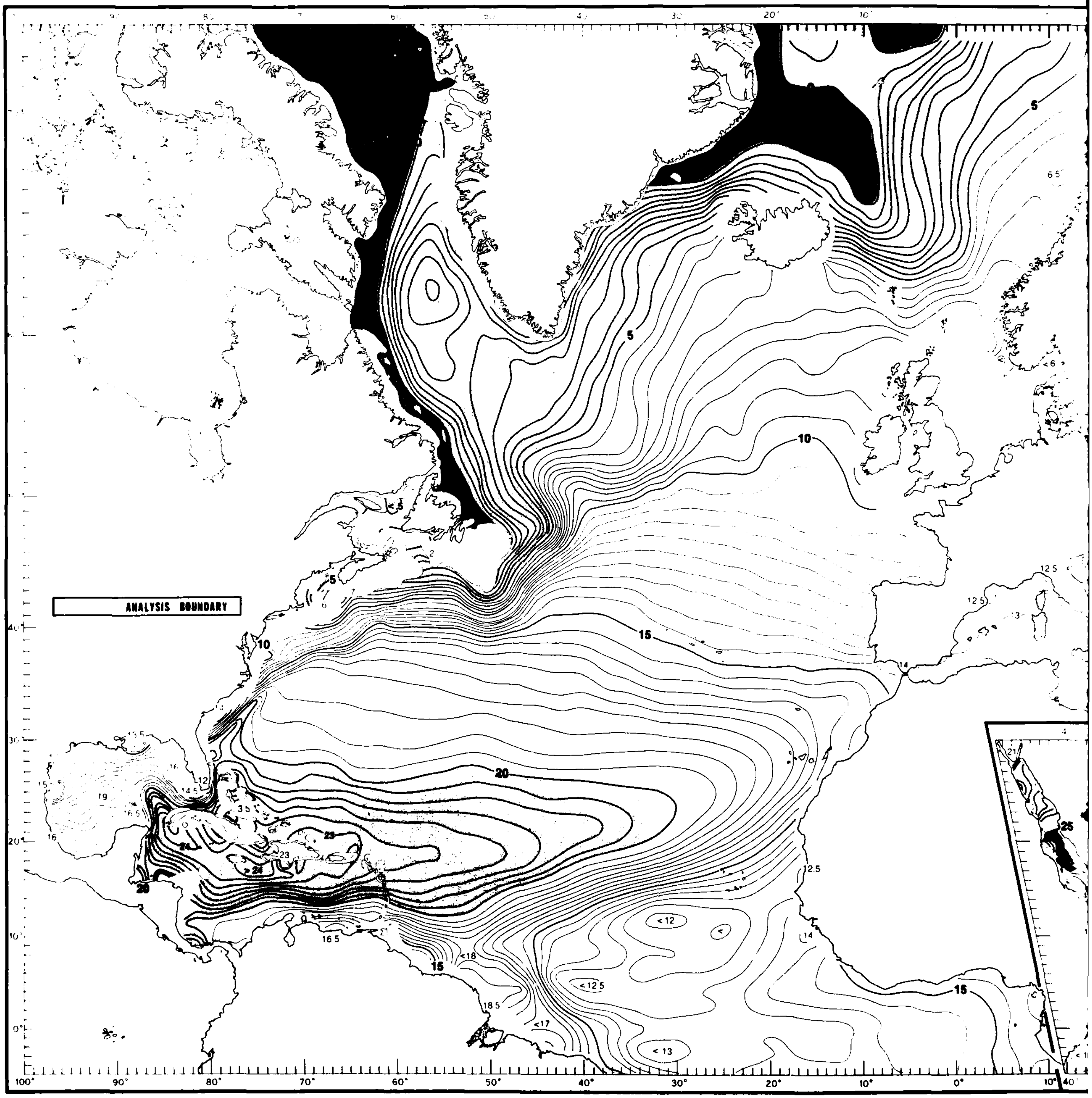
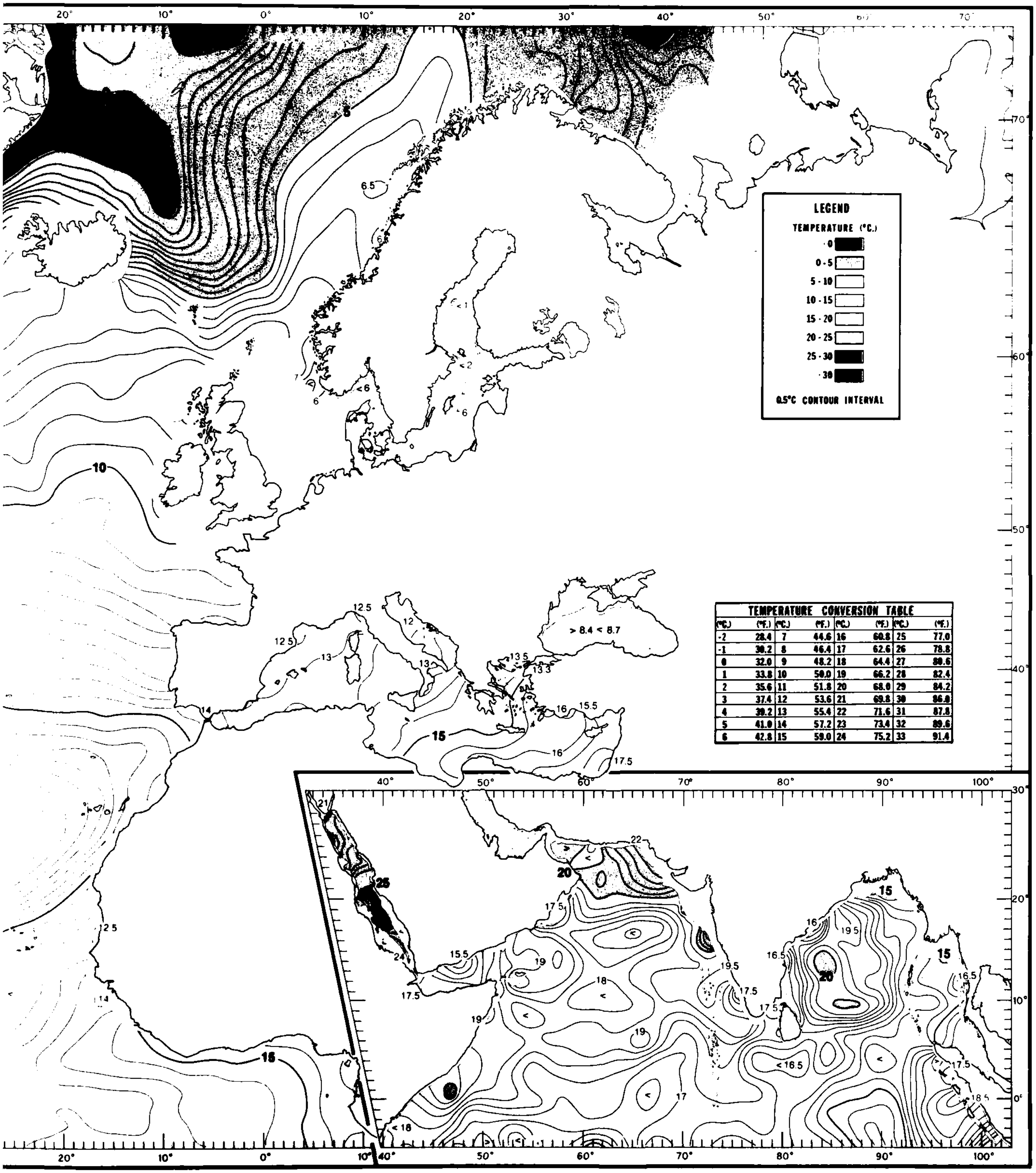


FIGURE 40. MARCH MEAN TEMPERATURES AT 492 FT (150 M)



TEMPERATURE CONVERSION TABLE							
(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

CH MEAN TEMPERATURES AT 492 FT (150 M)

2

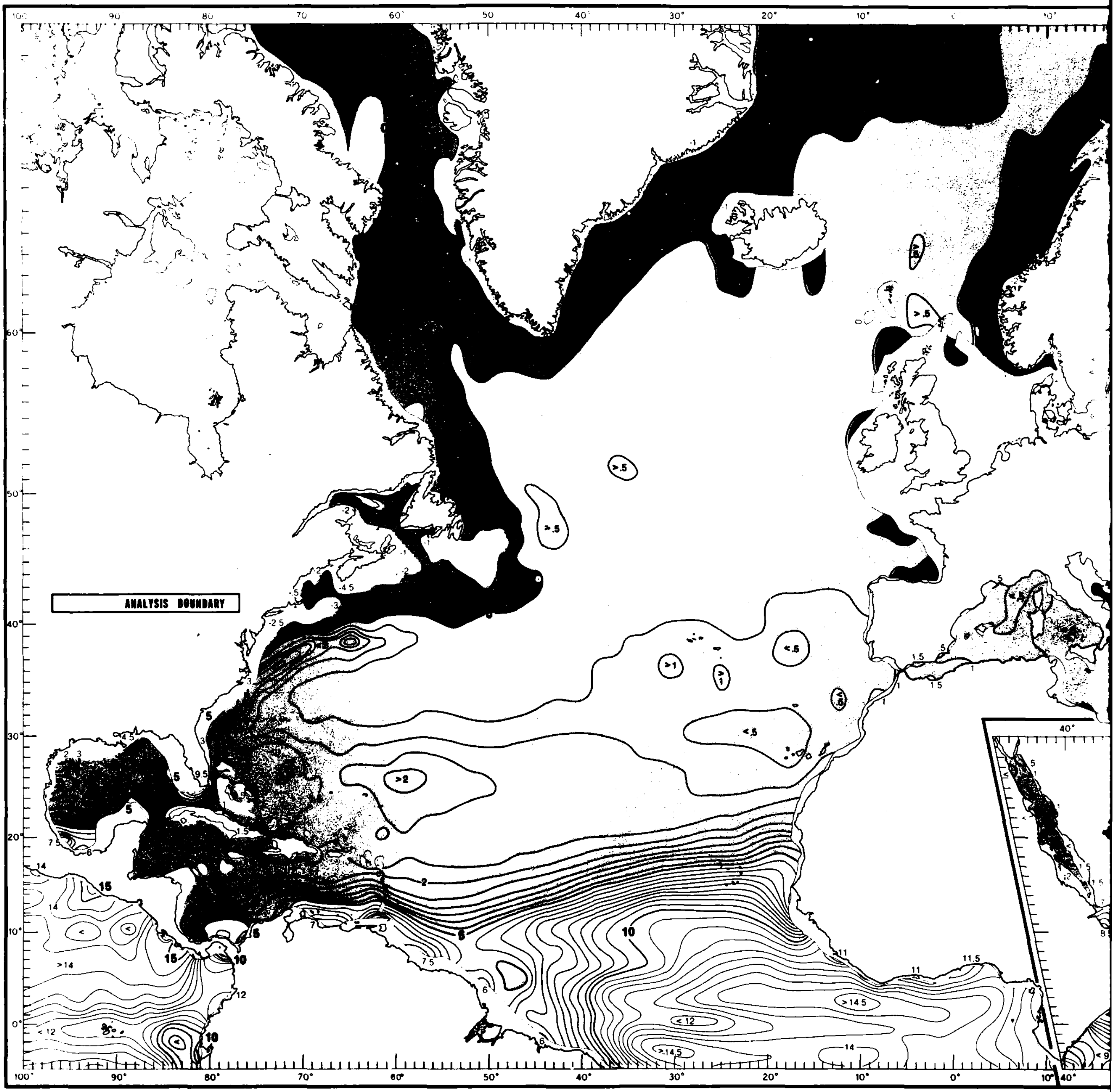
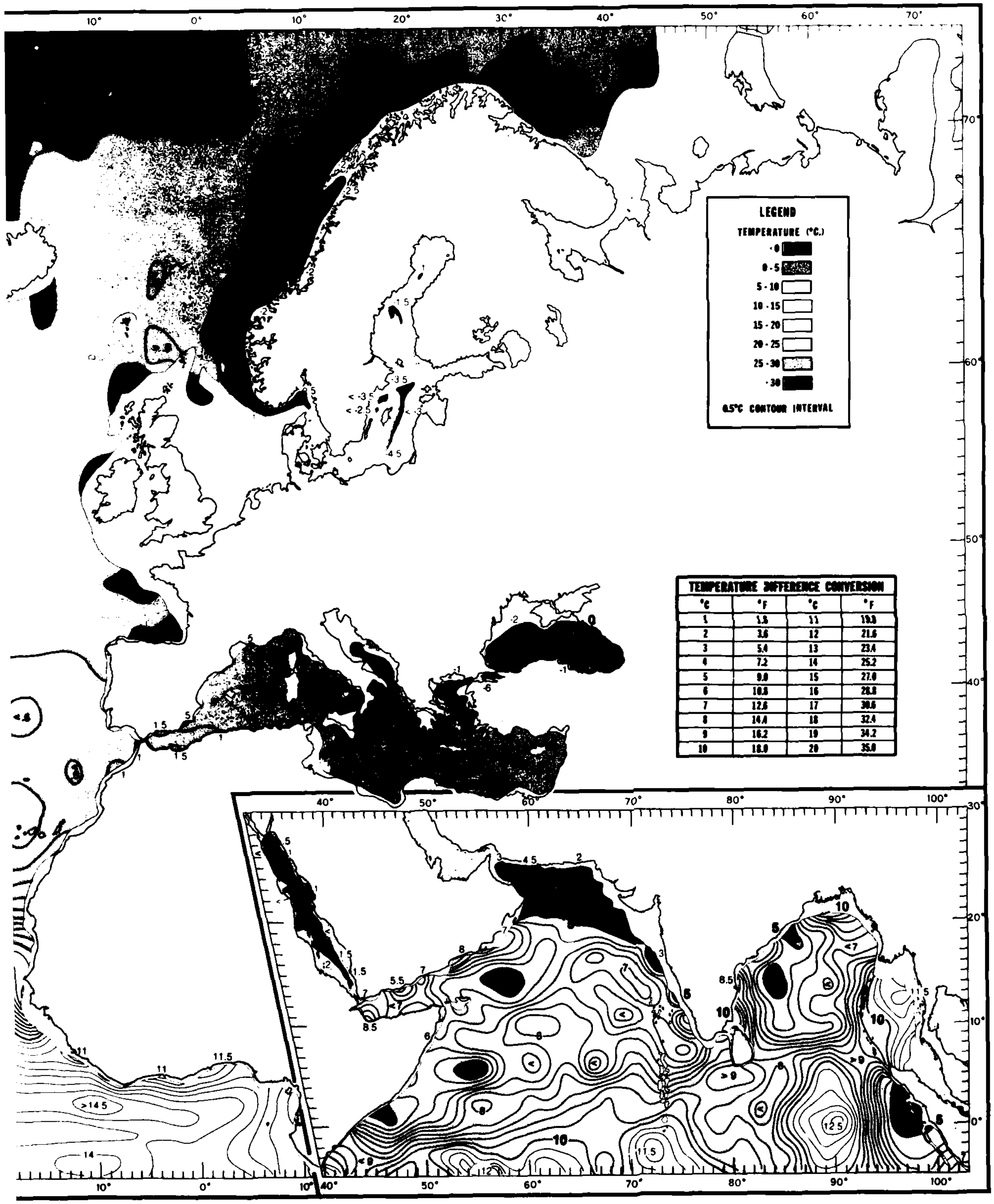


FIGURE 41. MARCH TEMPERATURE DIFFERENCE BETWEEN THE SURFACE AND 400 FT (T0



TEMPERATURE DIFFERENCE CONVERSION

°C	°F	°C	°F
1	1.8	11	19.8
2	3.6	12	21.6
3	5.4	13	23.4
4	7.2	14	25.2
5	9.0	15	27.0
6	10.8	16	28.8
7	12.6	17	30.6
8	14.4	18	32.4
9	16.2	19	34.2
10	18.0	20	35.0

RENCE BETWEEN THE SURFACE AND 400 FT (T_0-T_{400})

FIGURE 42. MARCH MEAN DEPTHS TO THE TOP OF THE THERMOCLINE

DEPTH CONVERSION TABLE

FEET	METERS	FEET	METERS
50	15	300	90
100	30	350	105
150	45	400	120
200	60	450	135
250	75	492	150

MARCH MEAN DEPTHS TO THE TOP OF THE THERMOCLINE

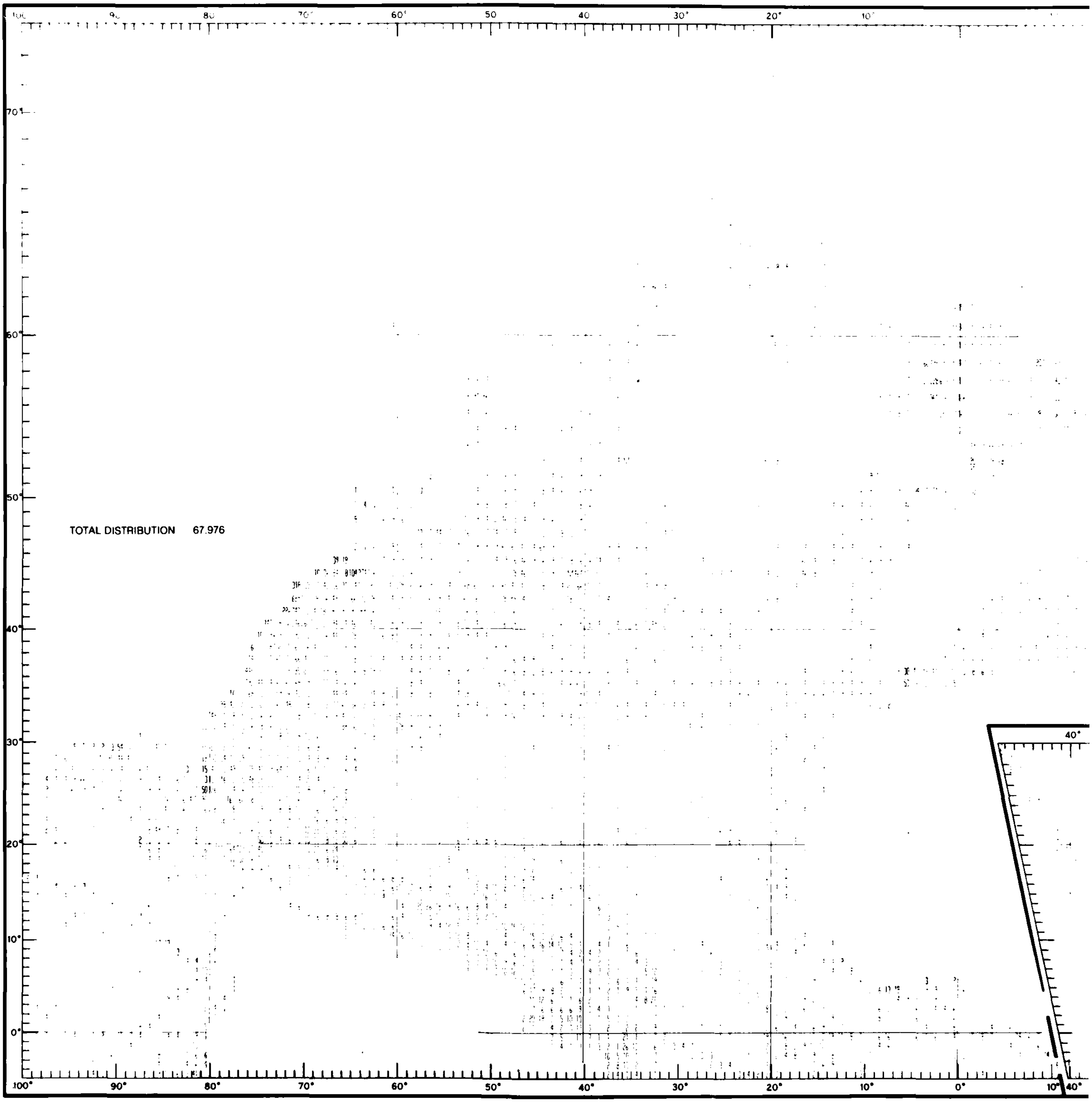
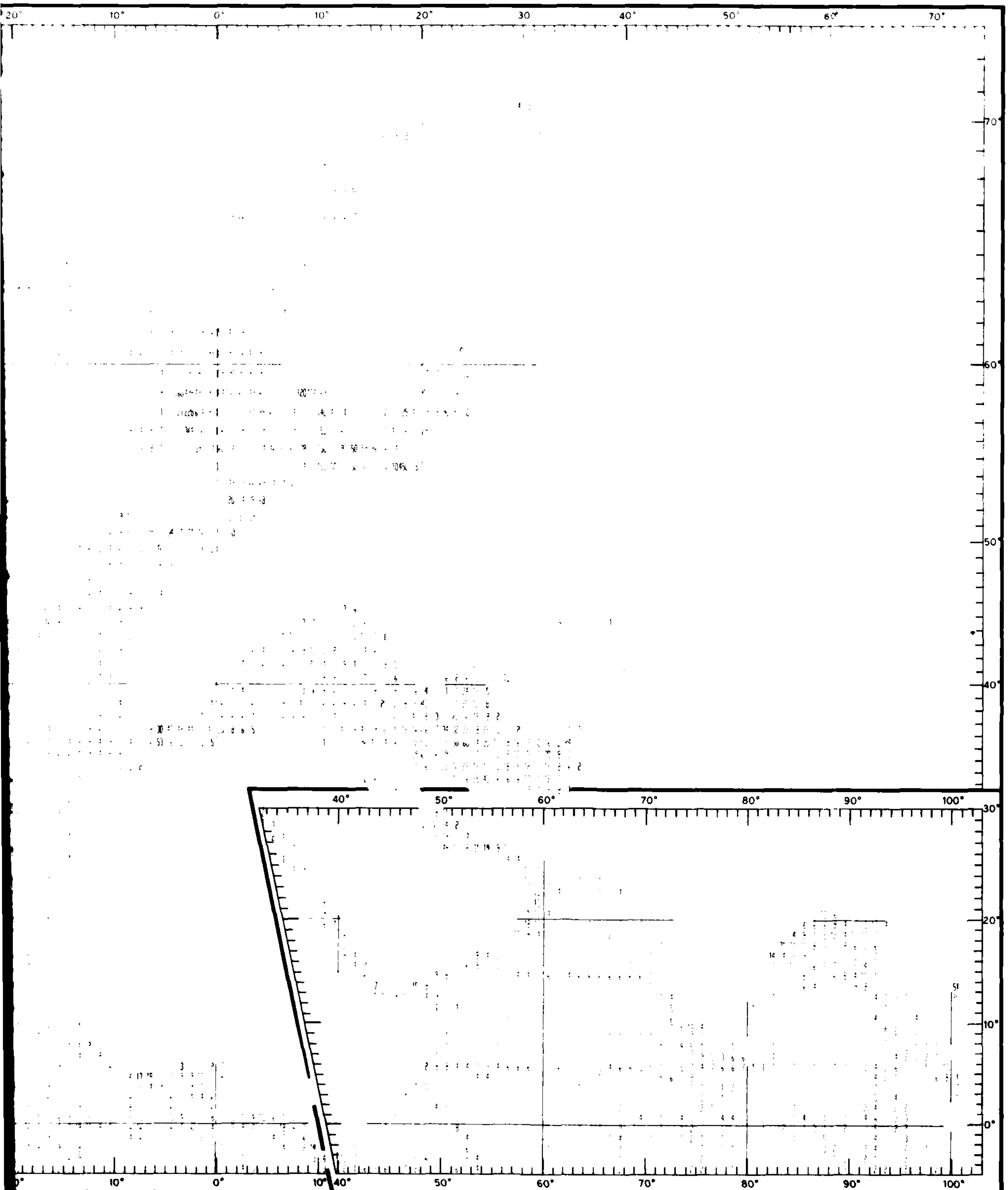


FIGURE 43. APRIL DATA DISTRIBUTION OF TEMPERATURES AT THE SURFAC



IBUTION OF TEMPERATURES AT THE SURFACE

2

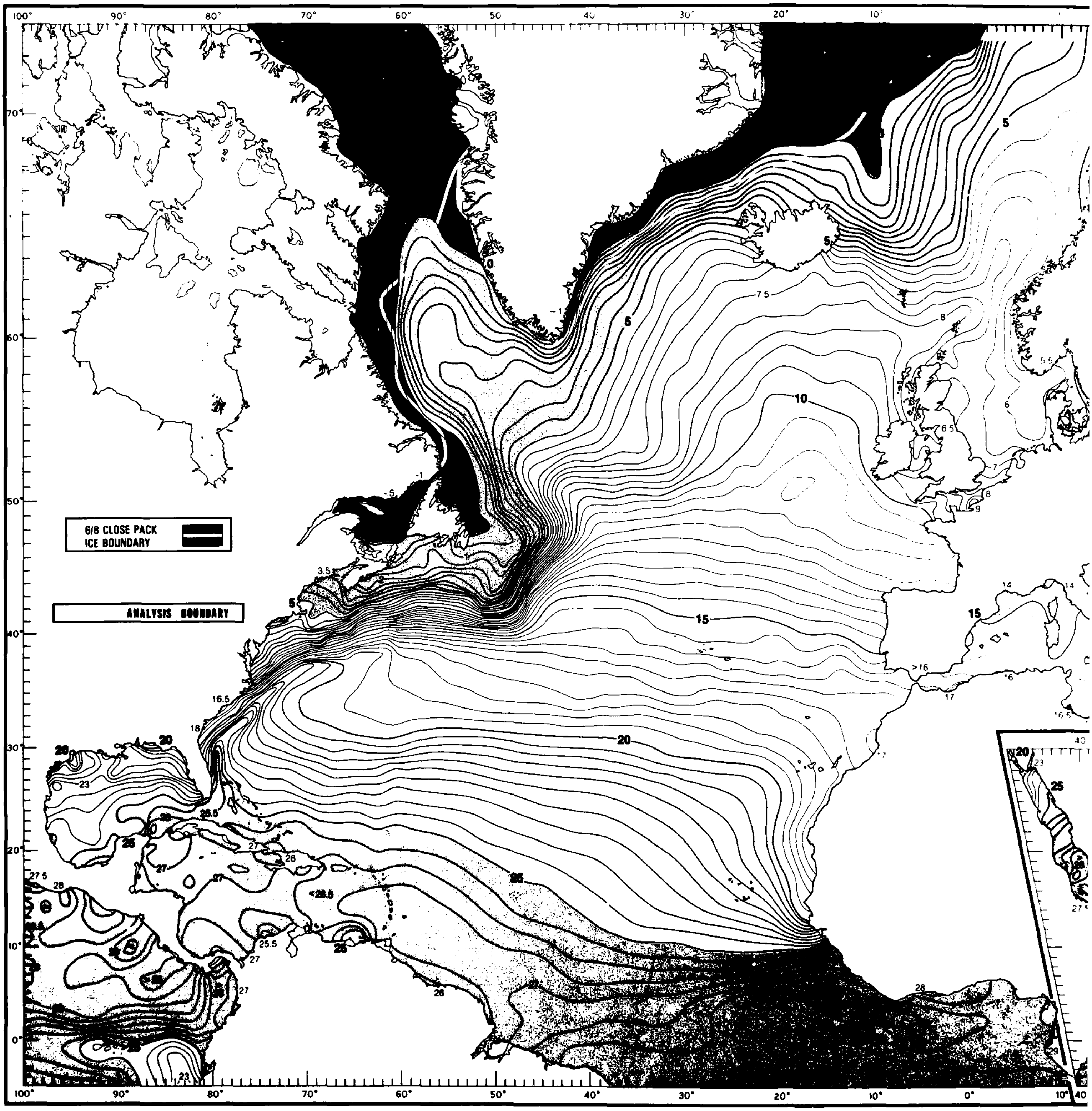
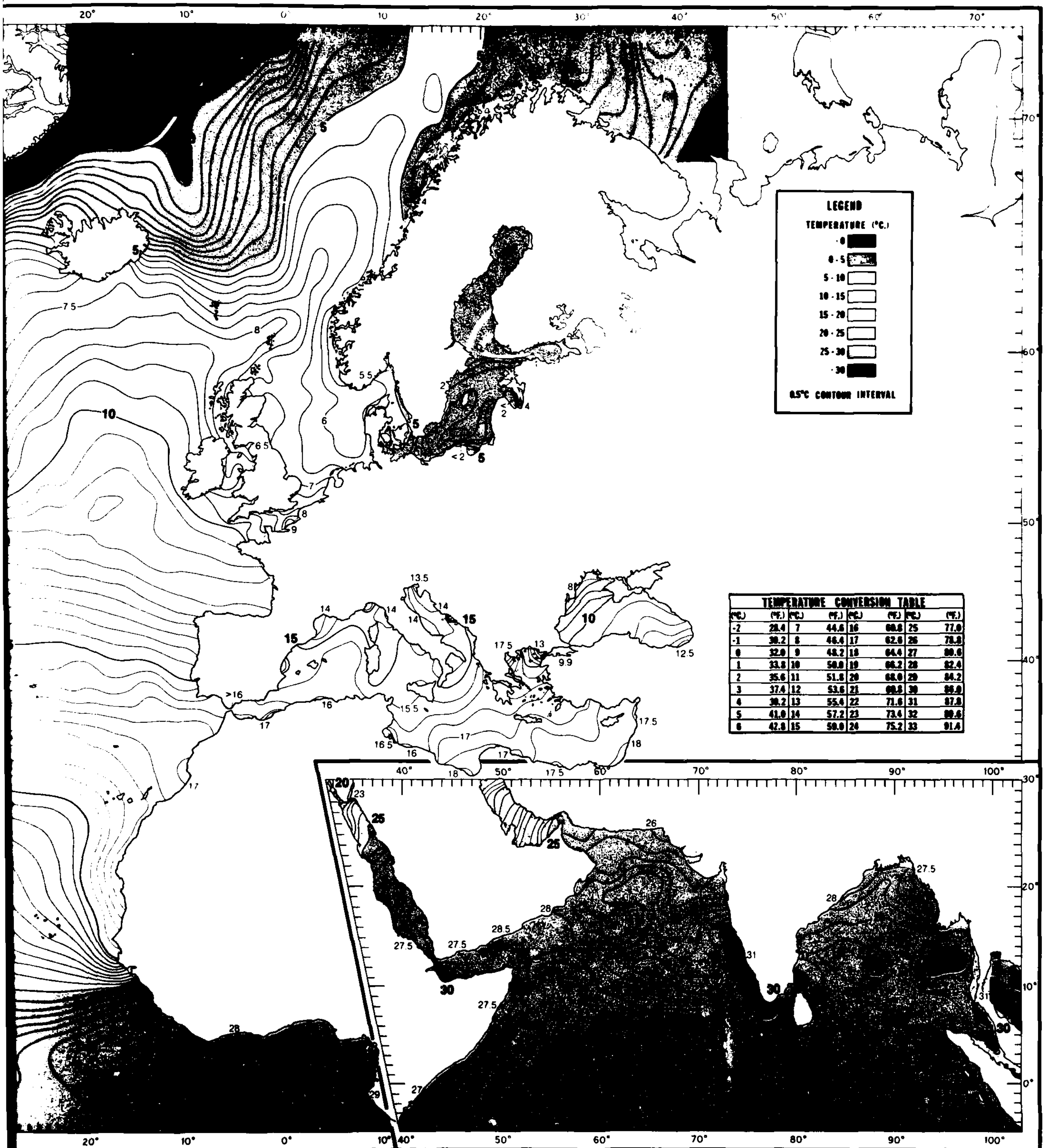


FIGURE 44. APRIL MEAN TEMPERATURES AT THE SURFACE



TEMPERATURE CONVERSION TABLE							
(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

APRIL MEAN TEMPERATURES AT THE SURFACE

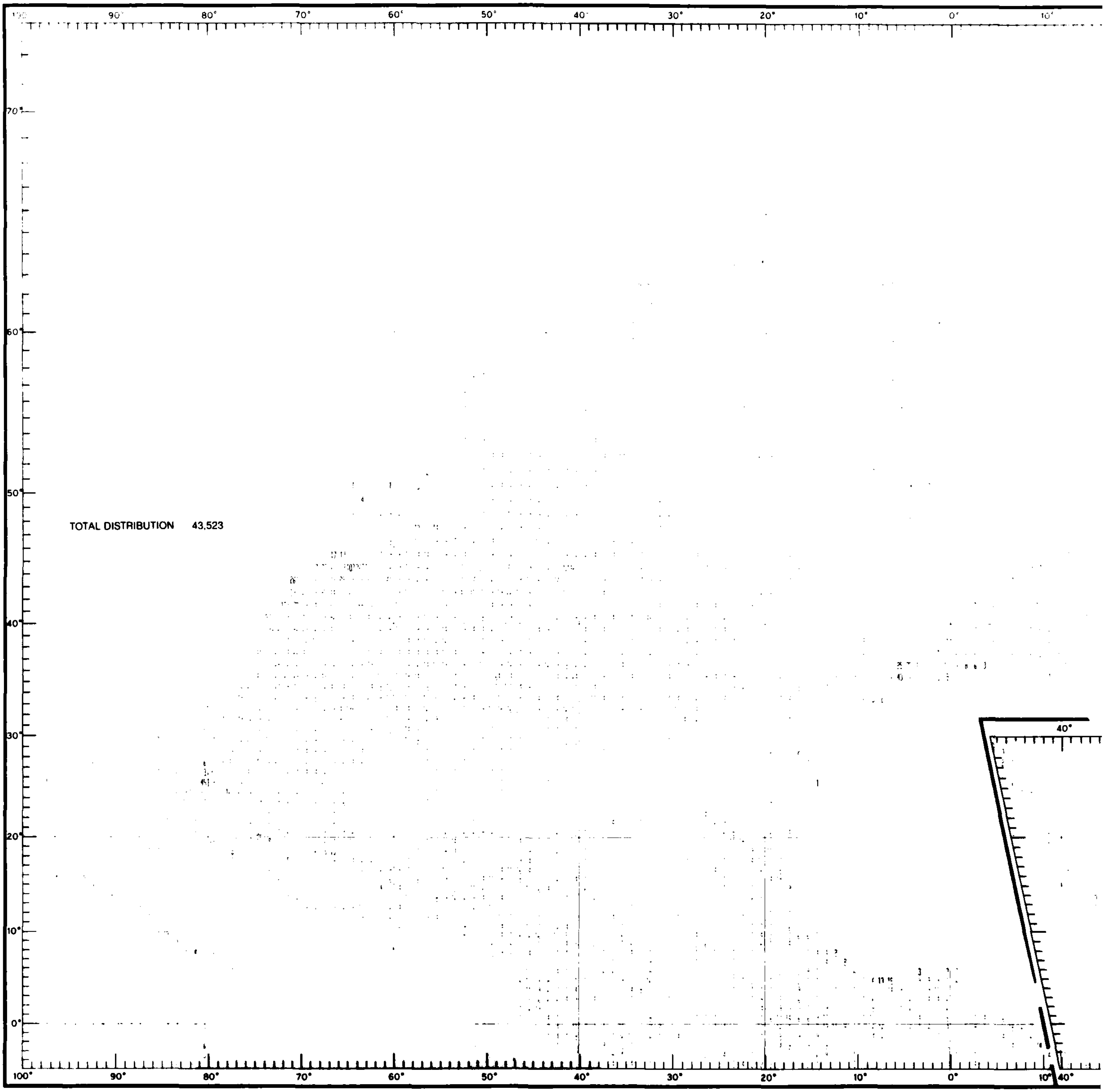
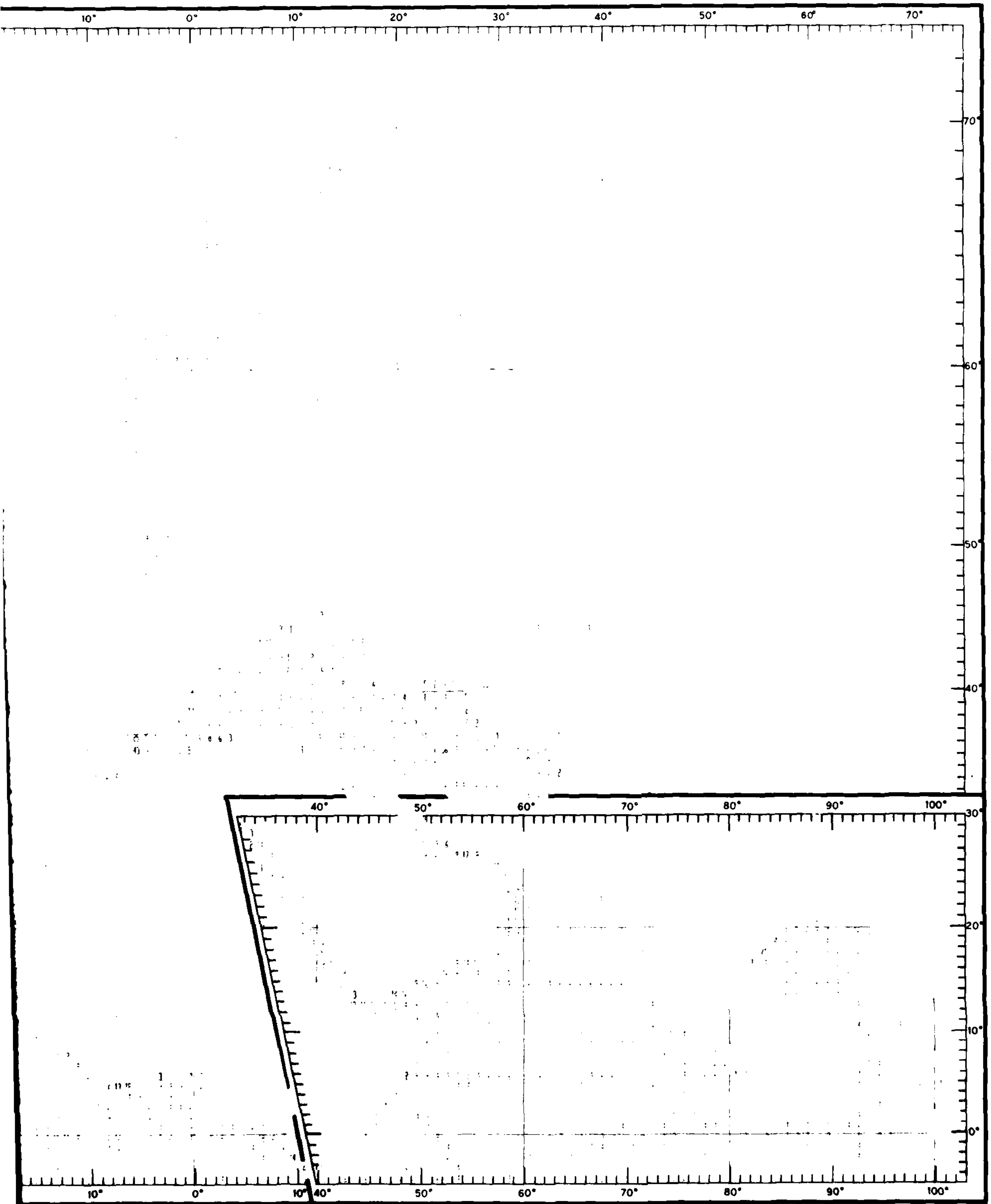


FIGURE 45. APRIL DATA DISTRIBUTION OF TEMPERATURES AT 100 FT (30 M)

1



TION OF TEMPERATURES AT 100 FT (30 M)

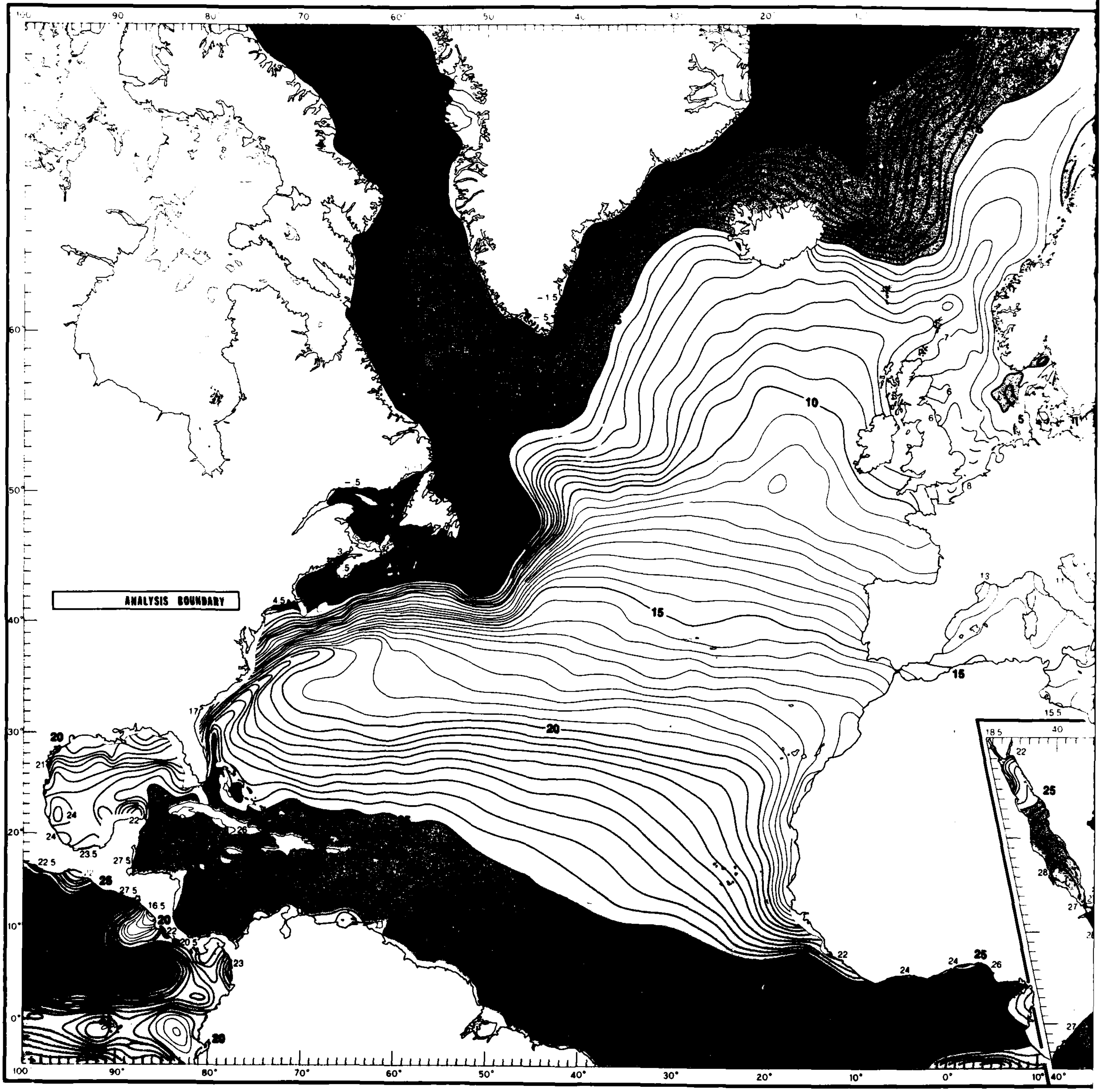
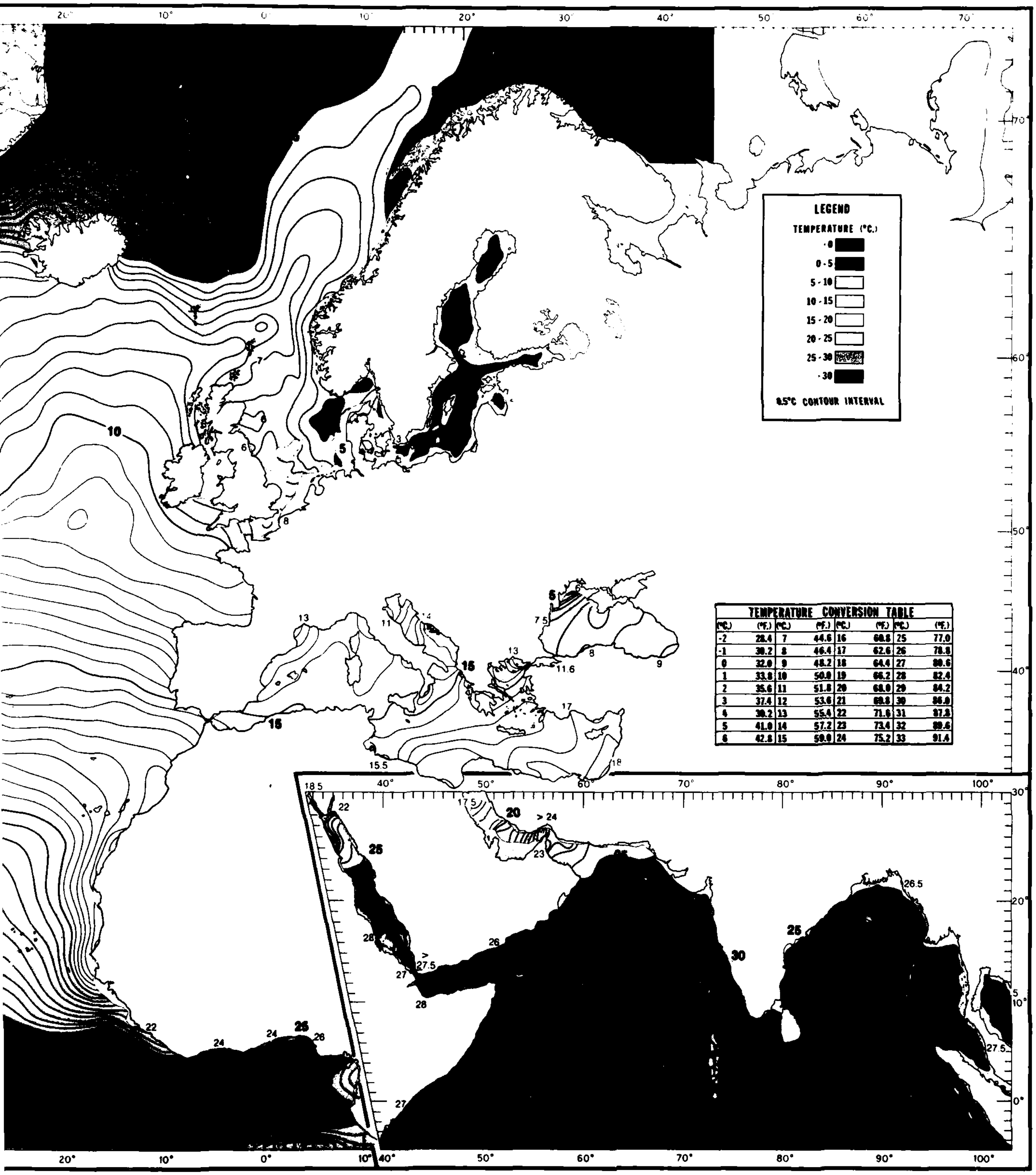


FIGURE 46. APRIL MEAN TEMPERATURES AT 100 FT (30 M)

1



TEMPERATURE CONVERSION TABLE							
(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

IL MEAN TEMPERATURES AT 100 FT (30 M)

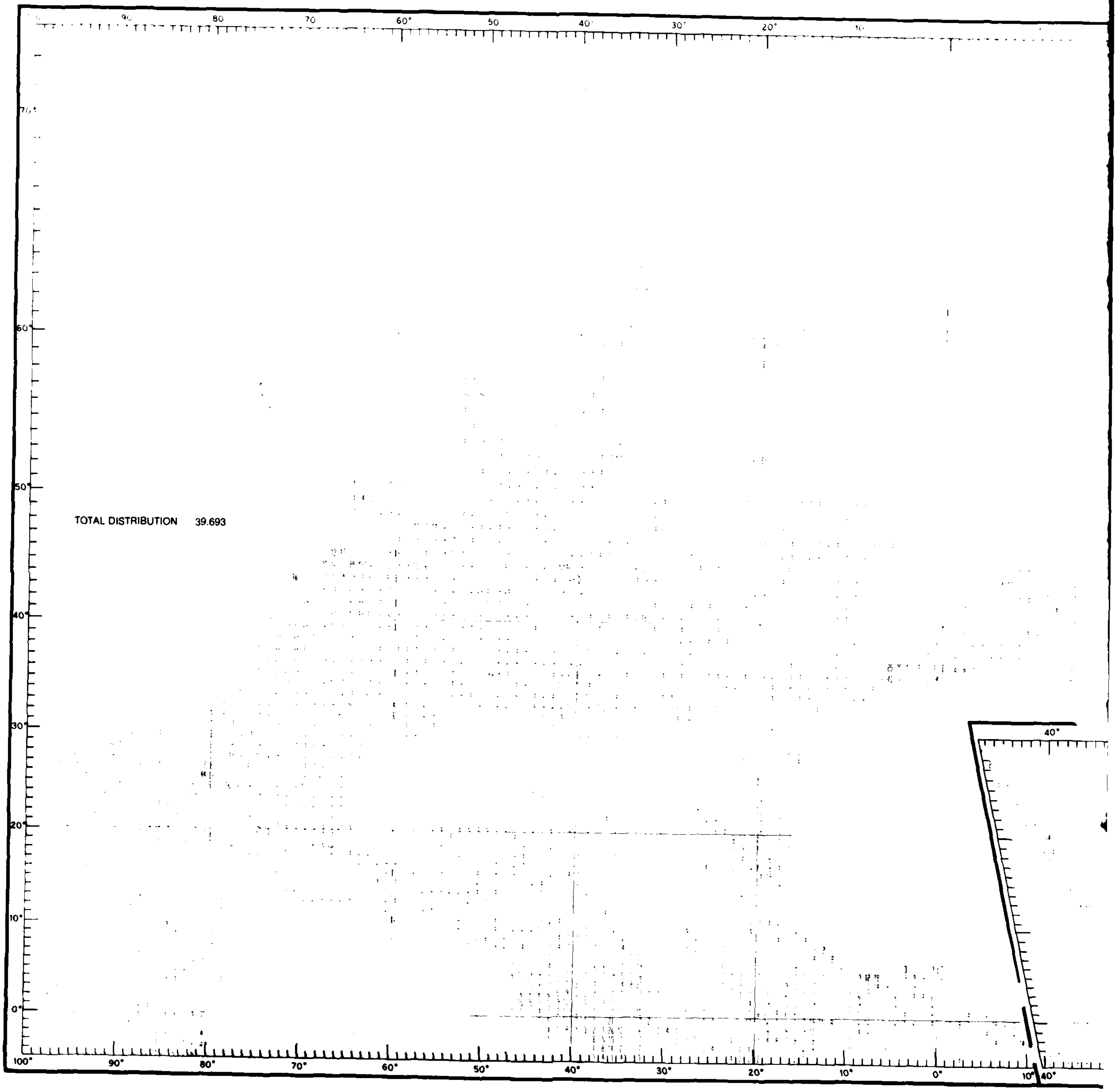
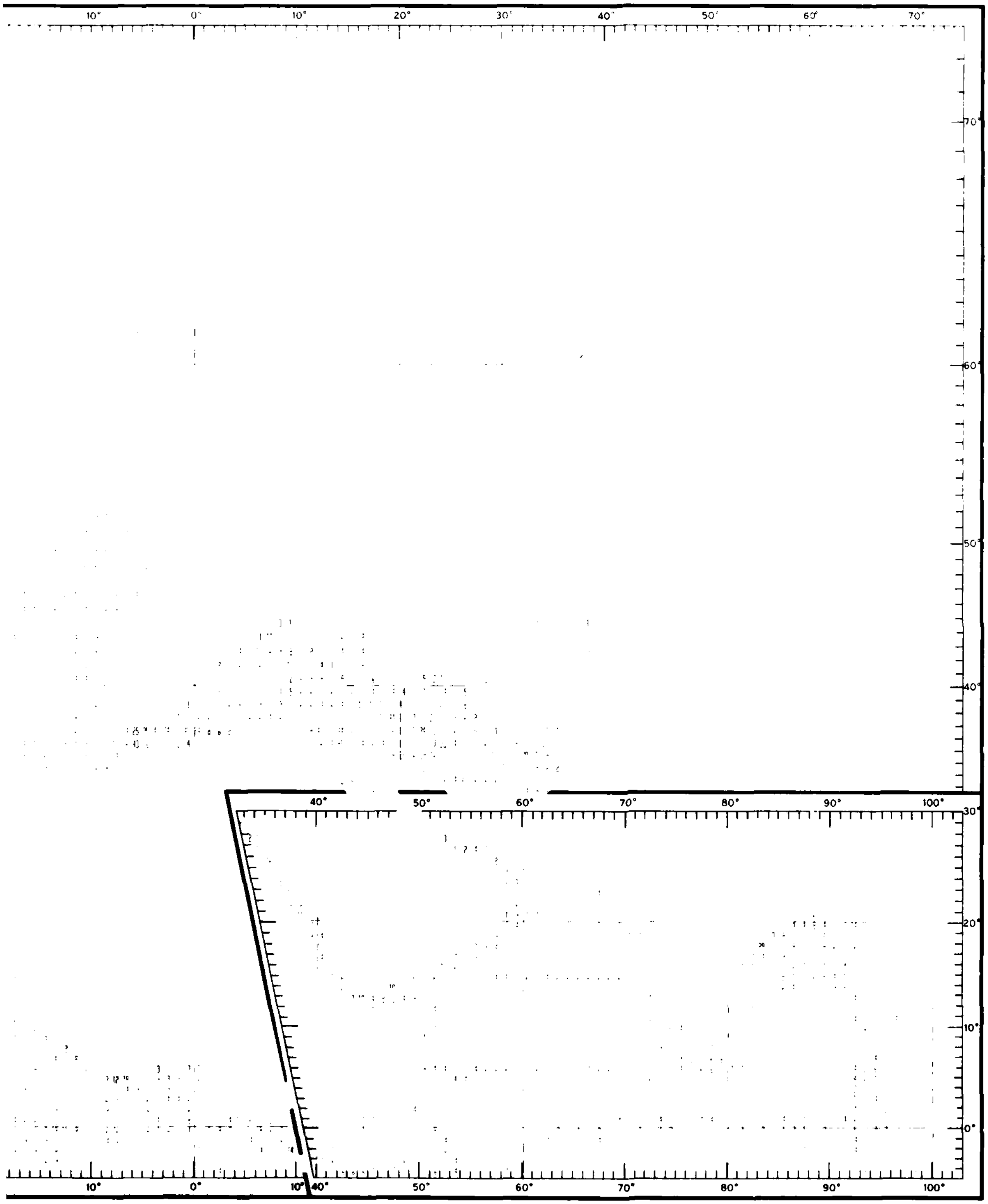


FIGURE 47. APRIL DATA DISTRIBUTION OF TEMPERATURES AT 200 FT (60 M)



IUTION OF TEMPERATURES AT 200 FT (60 M)

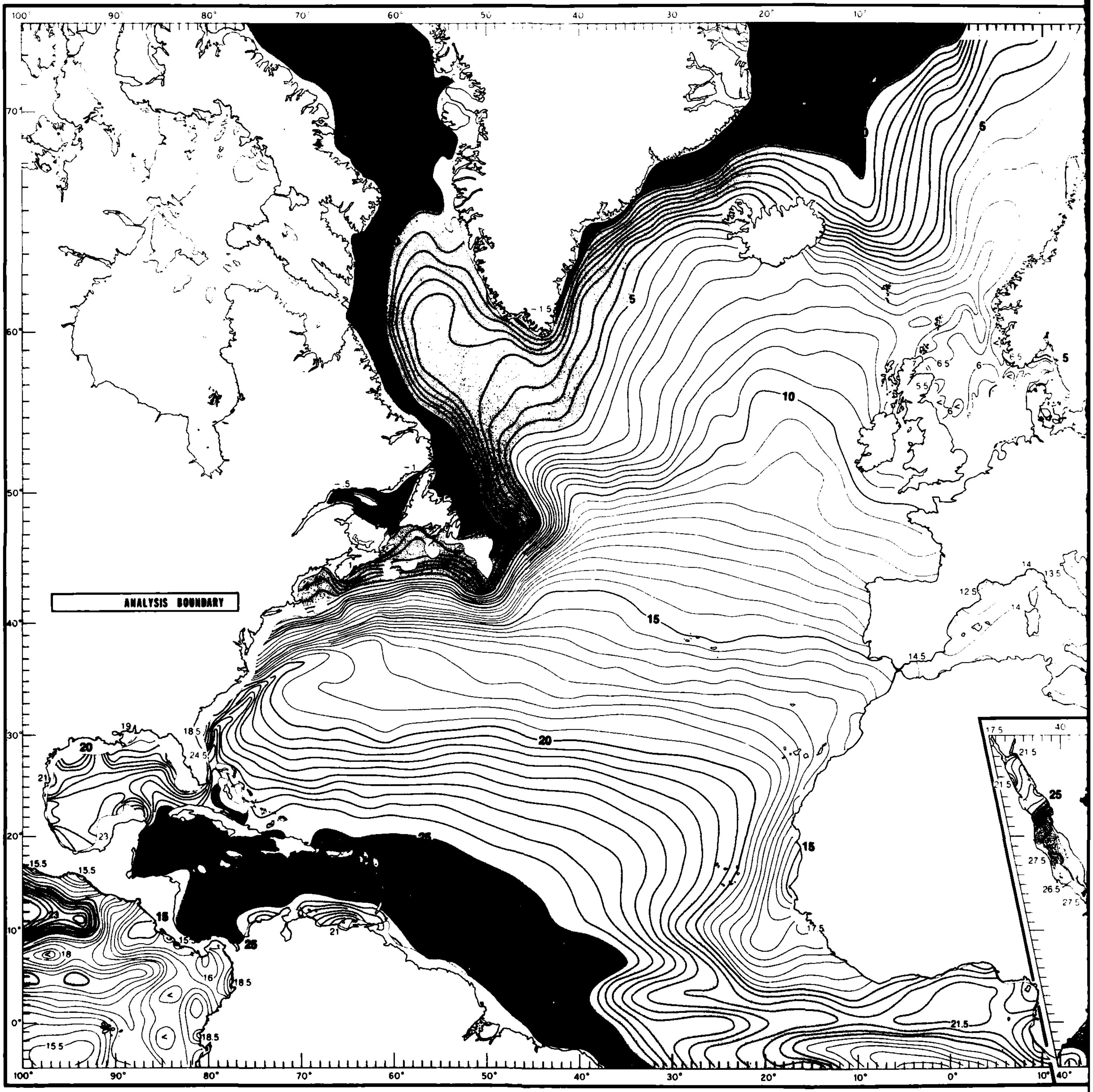
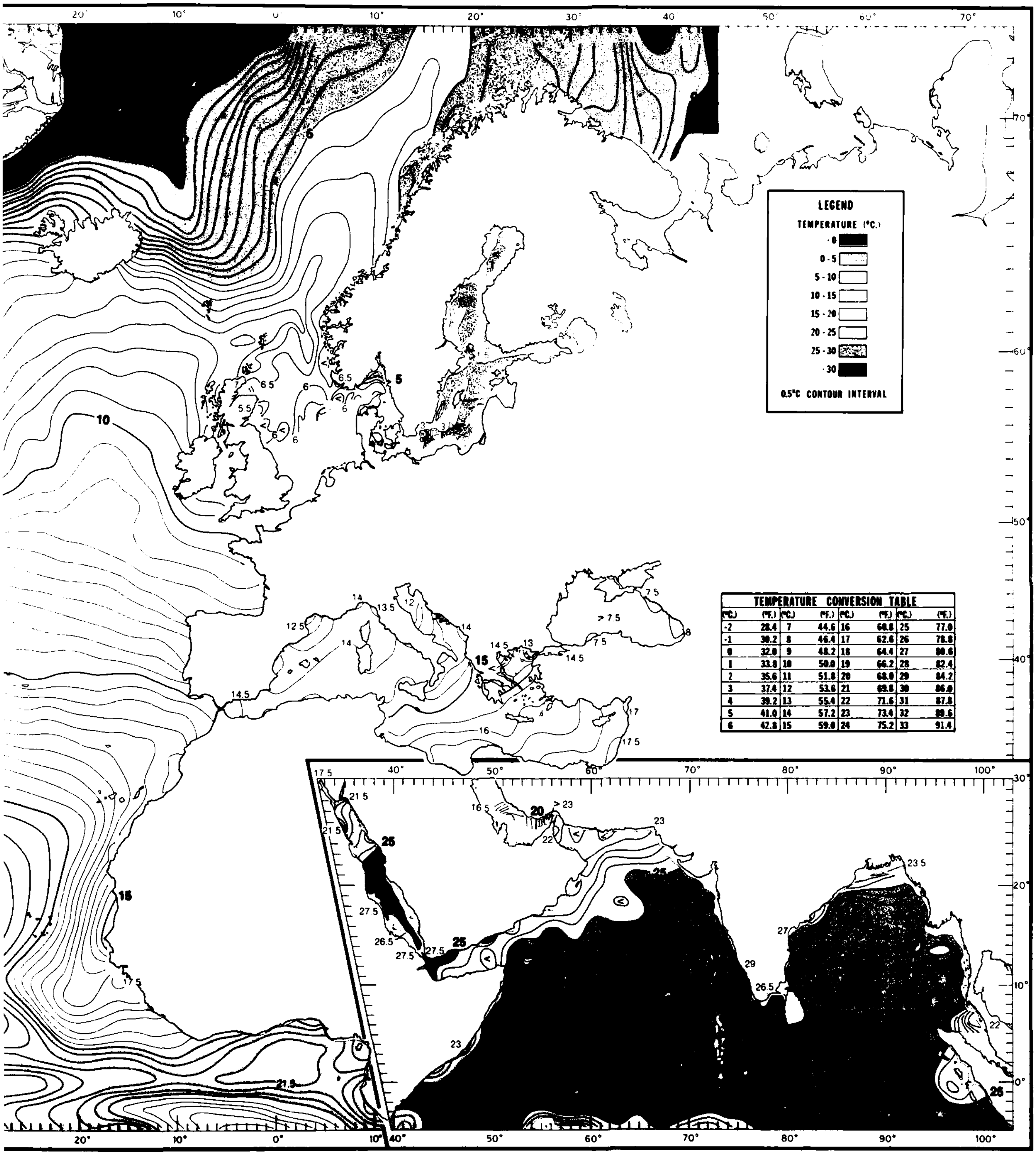


FIGURE 48. APRIL MEAN TEMPERATURES AT 200 FT (60 M)



TEMPERATURE CONVERSION TABLE

(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

. APRIL MEAN TEMPERATURES AT 200 FT (60 M)

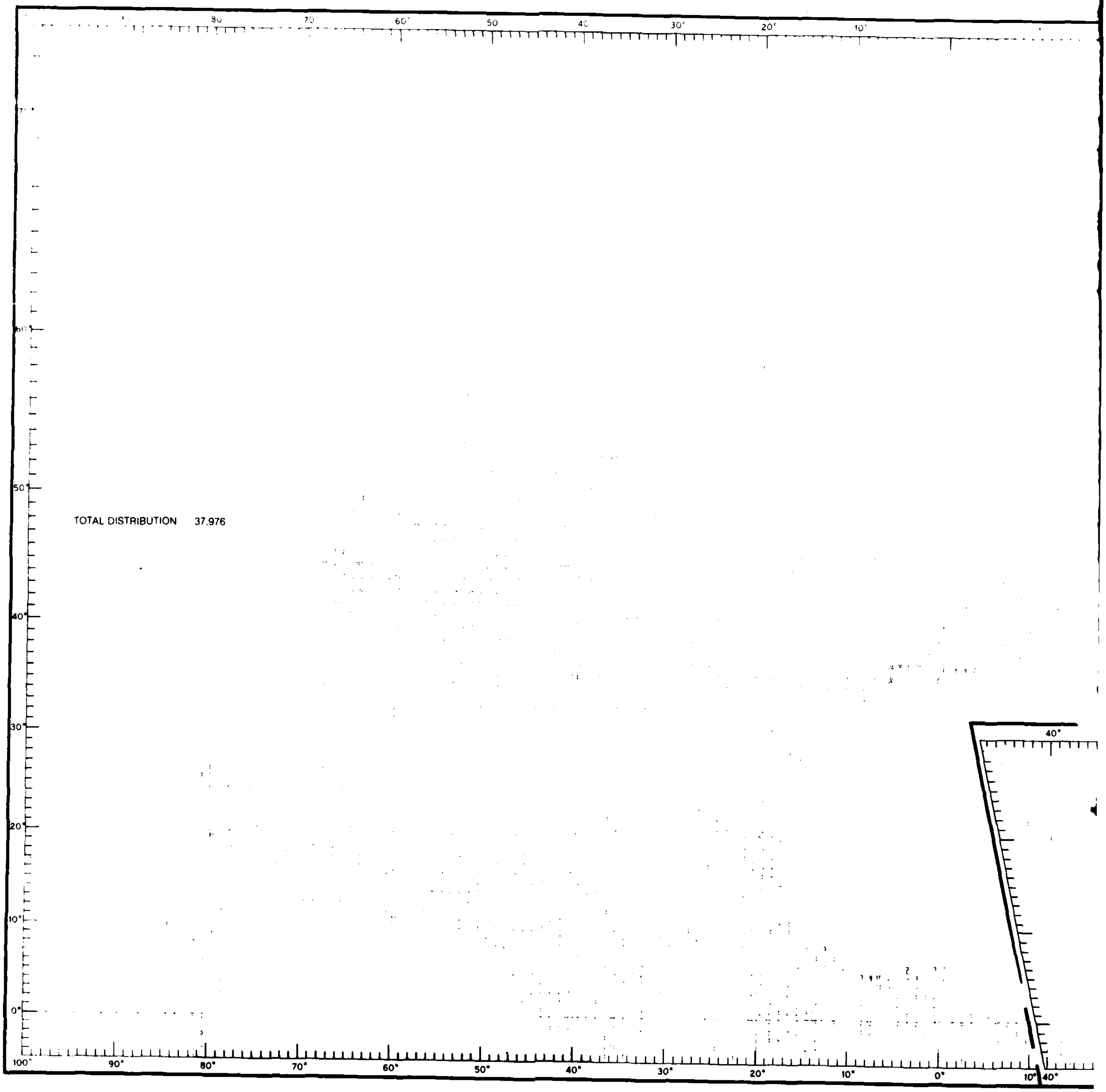
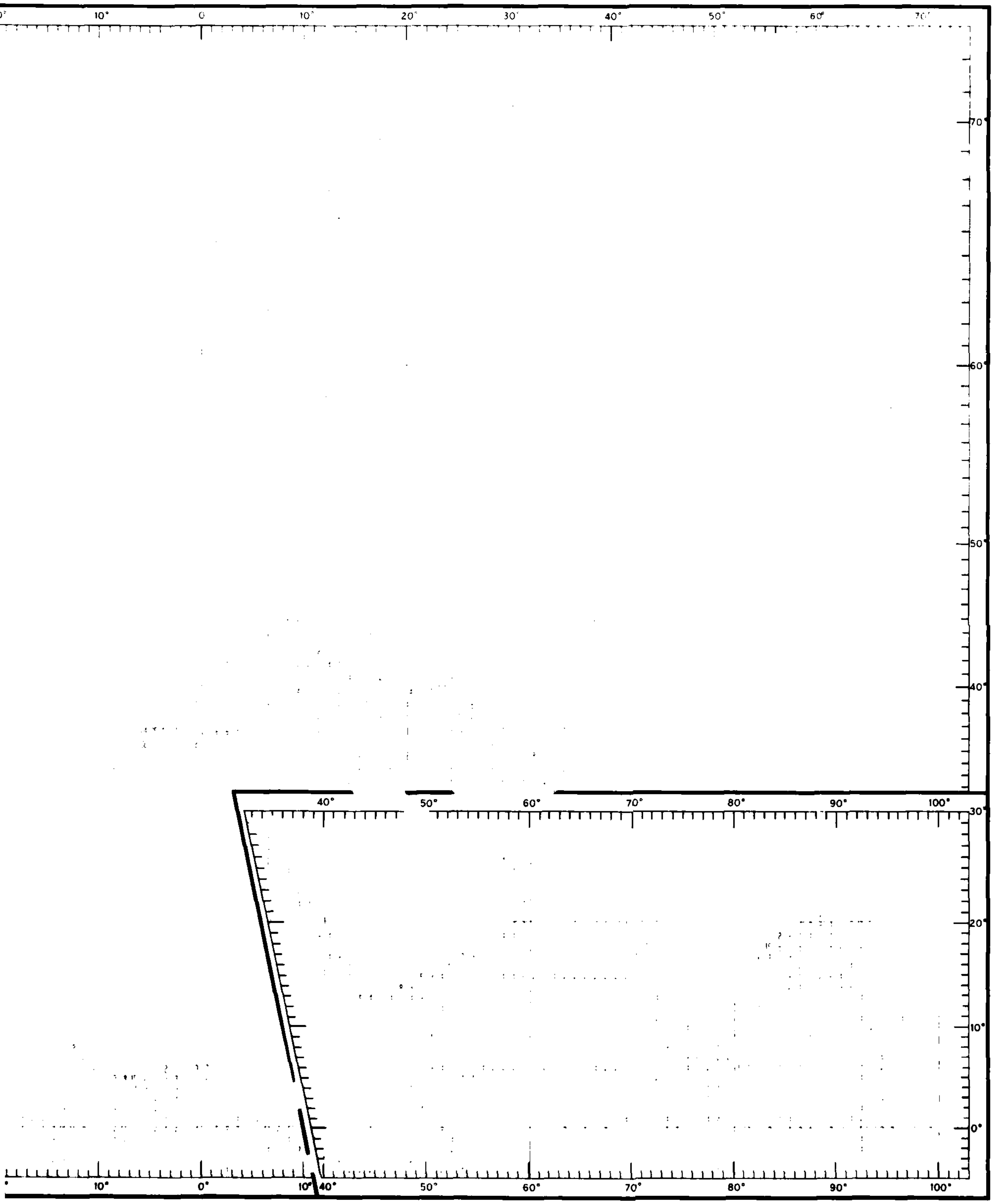


FIGURE 49. APRIL DATA DISTRIBUTION OF TEMPERATURES AT 300 FT (90 M)



IBUTION OF TEMPERATURES AT 300 FT (90 M)

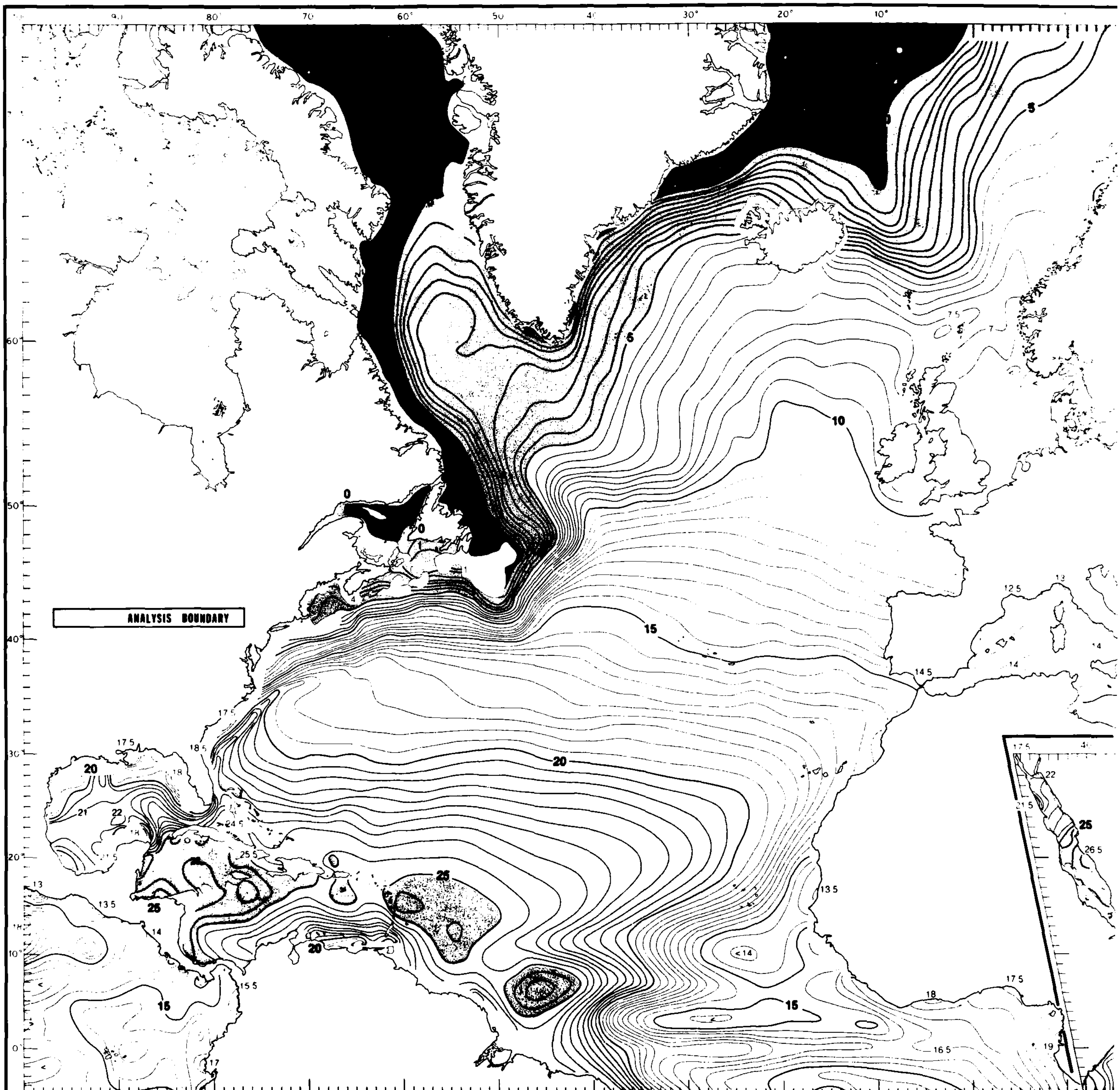
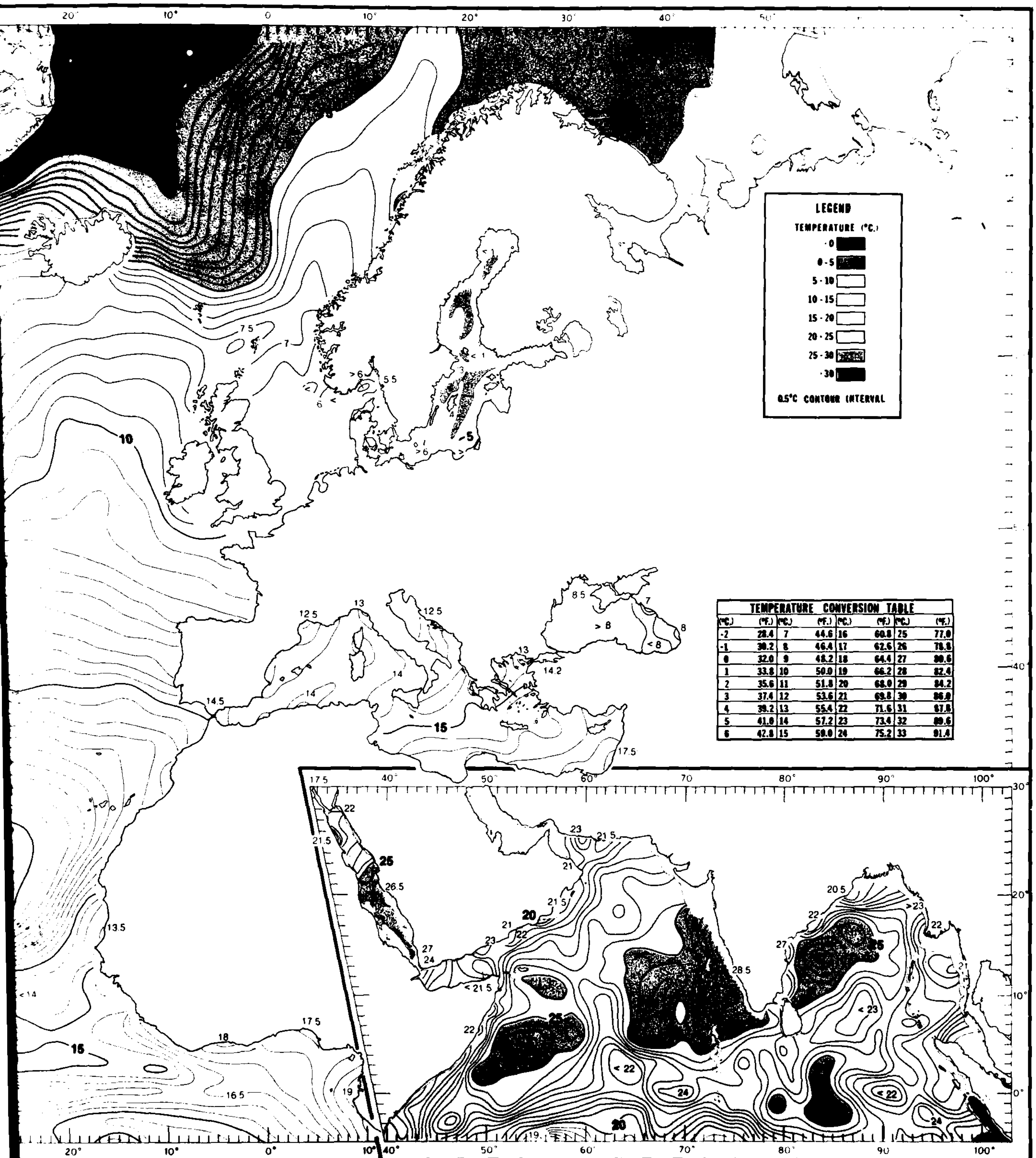


FIGURE 50. APRIL MEAN TEMPERATURES AT 300 FT (90 M)



TEMPERATURE CONVERSION TABLE							
(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

PRIL MEAN TEMPERATURES AT 300 FT (90 M)

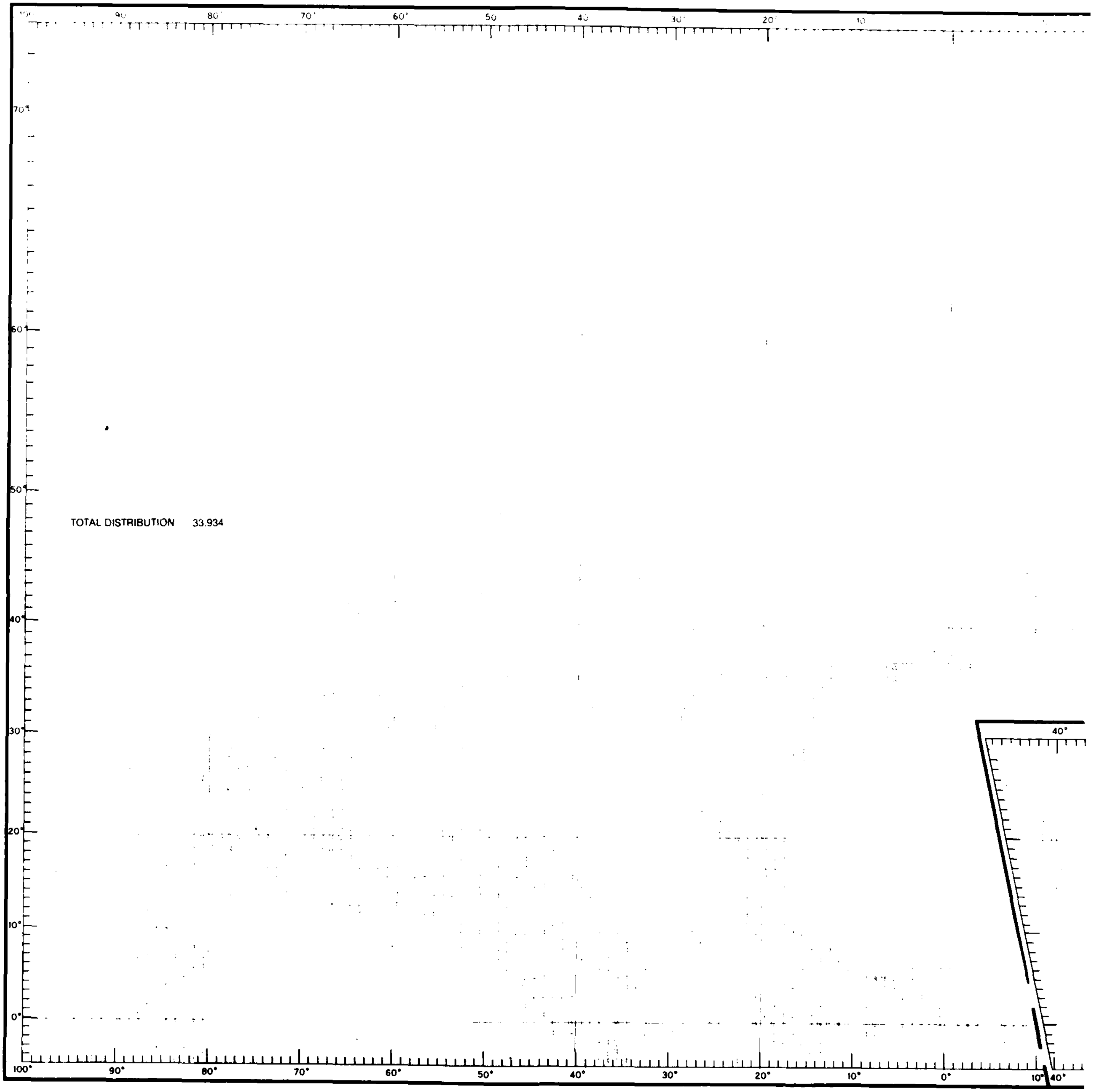
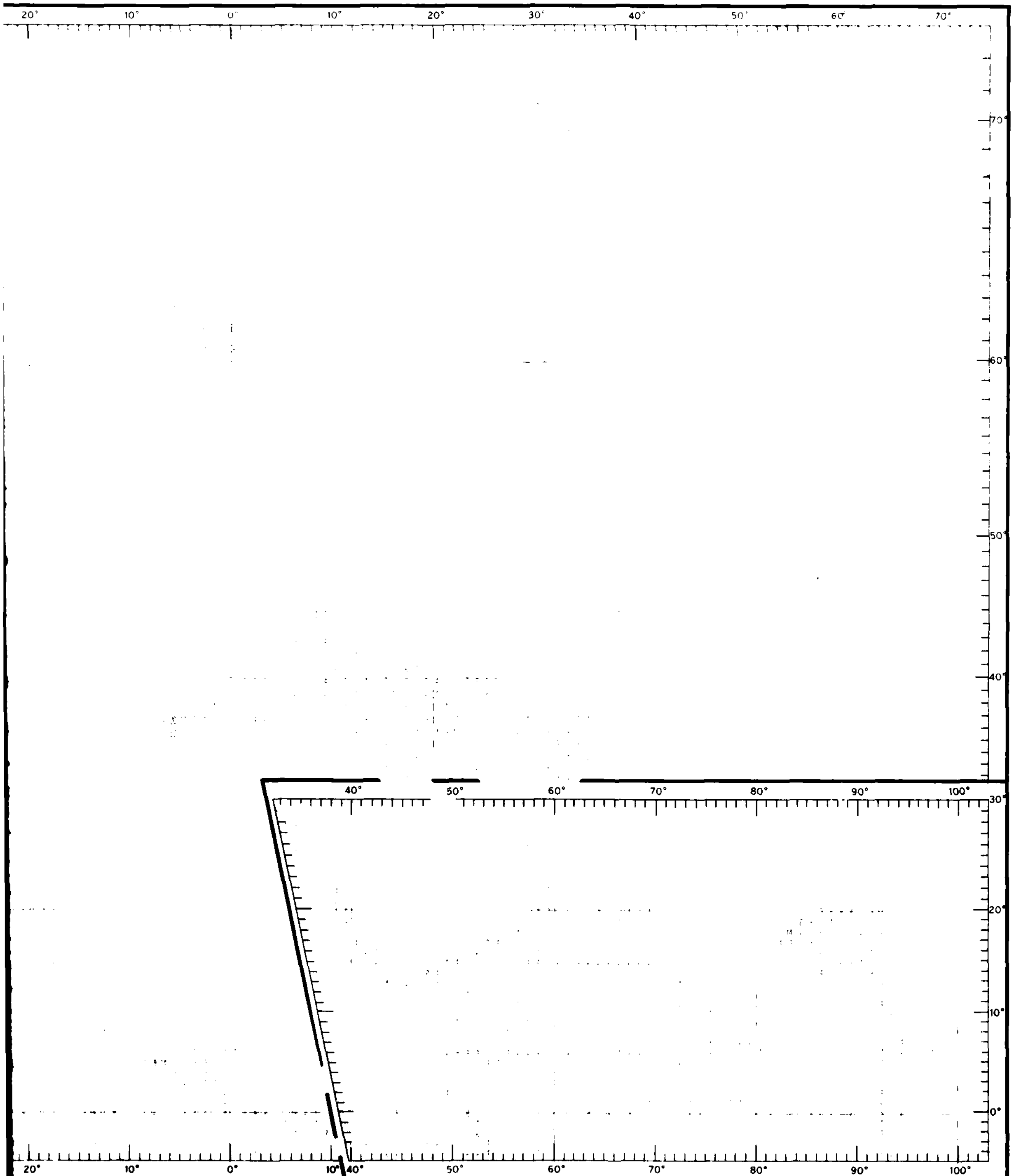


FIGURE 51. APRIL DATA DISTRIBUTION OF TEMPERATURES AT 400 FT (120 M)

1



TRIBUTION OF TEMPERATURES AT 400 FT (120 M)

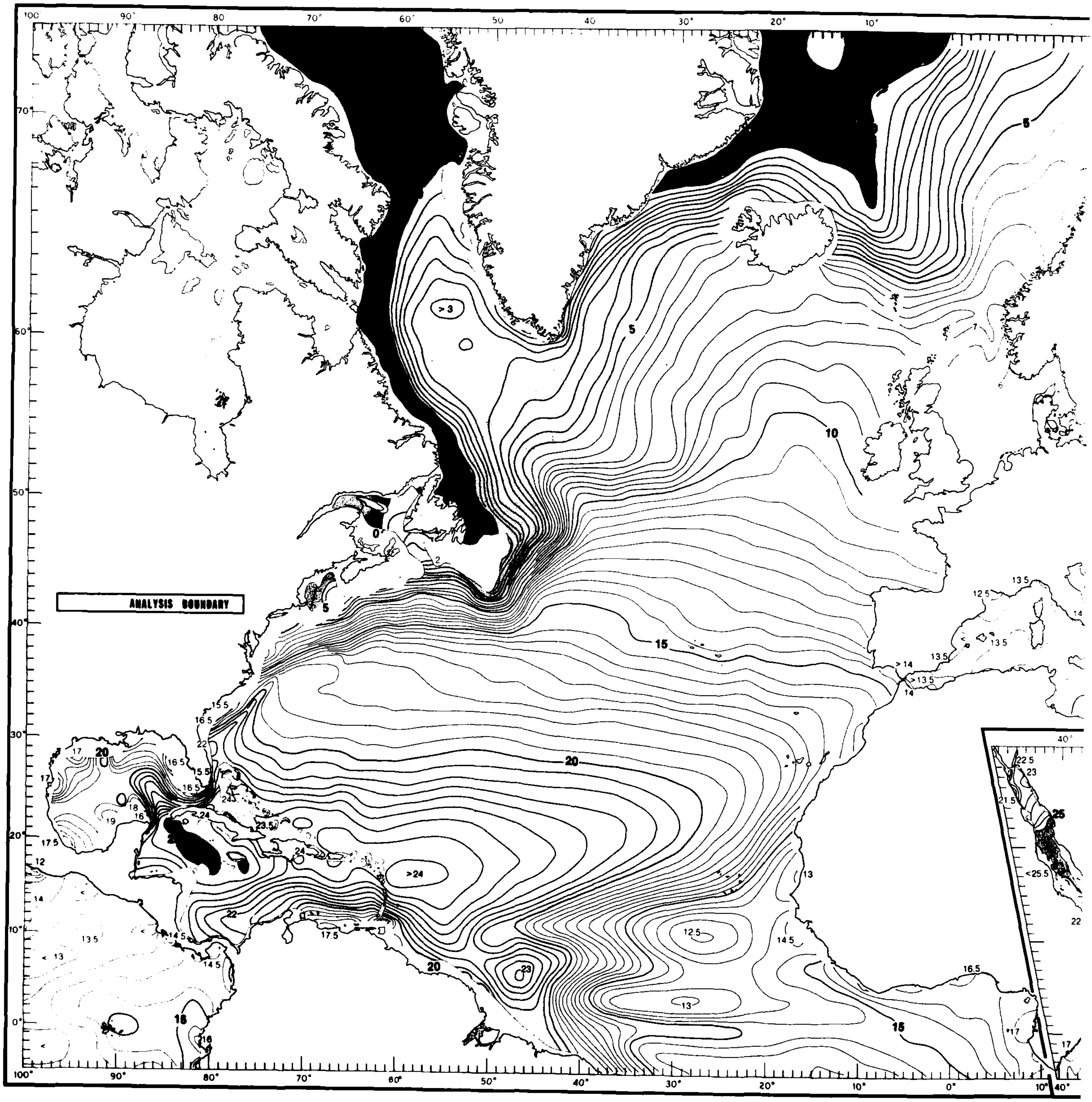
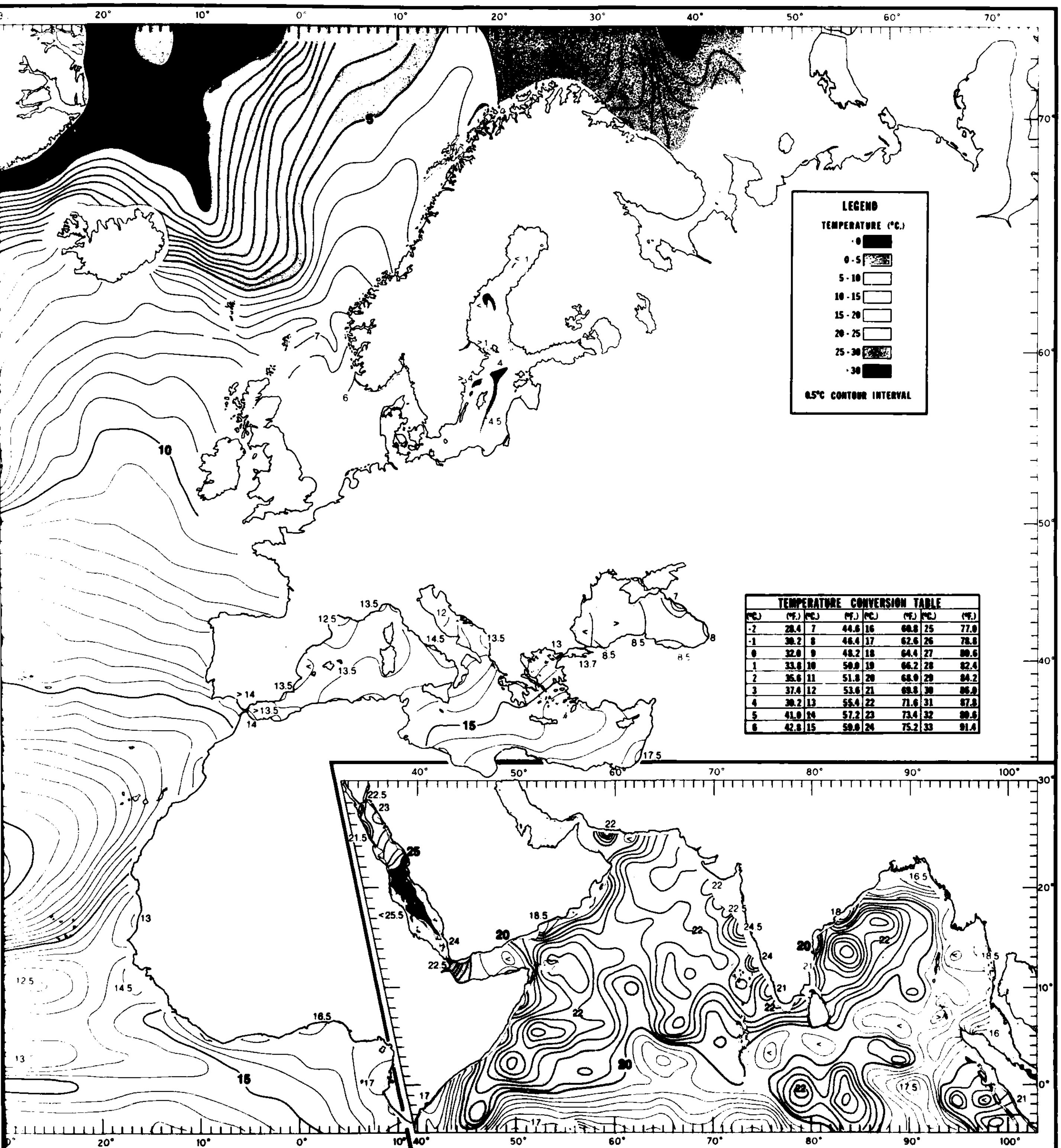


FIGURE 52. APRIL MEAN TEMPERATURES AT 400 FT (120 M)



TEMPERATURE CONVERSION TABLE							
(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

E 52. APRIL MEAN TEMPERATURES AT 400 FT (120 M)

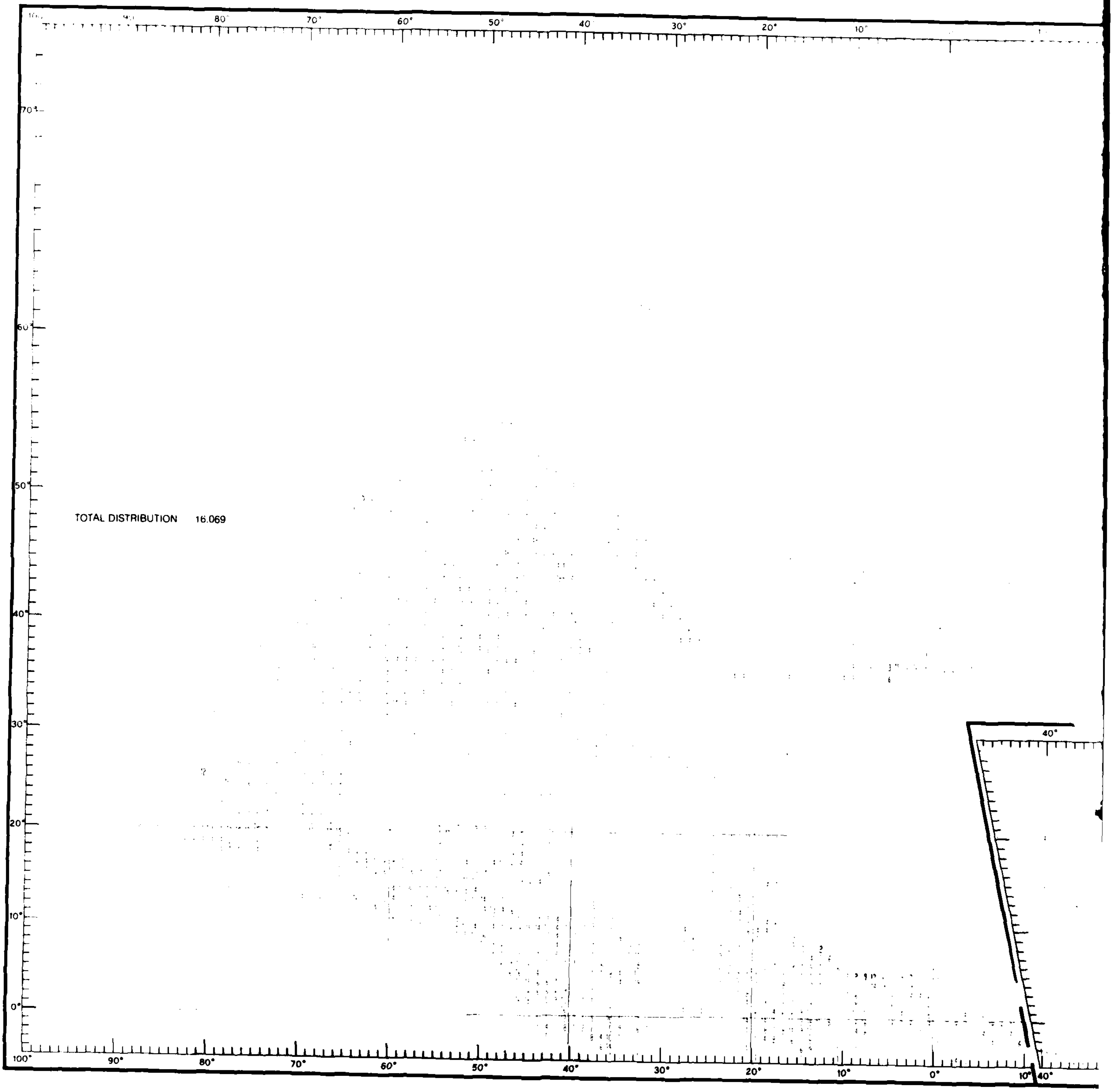
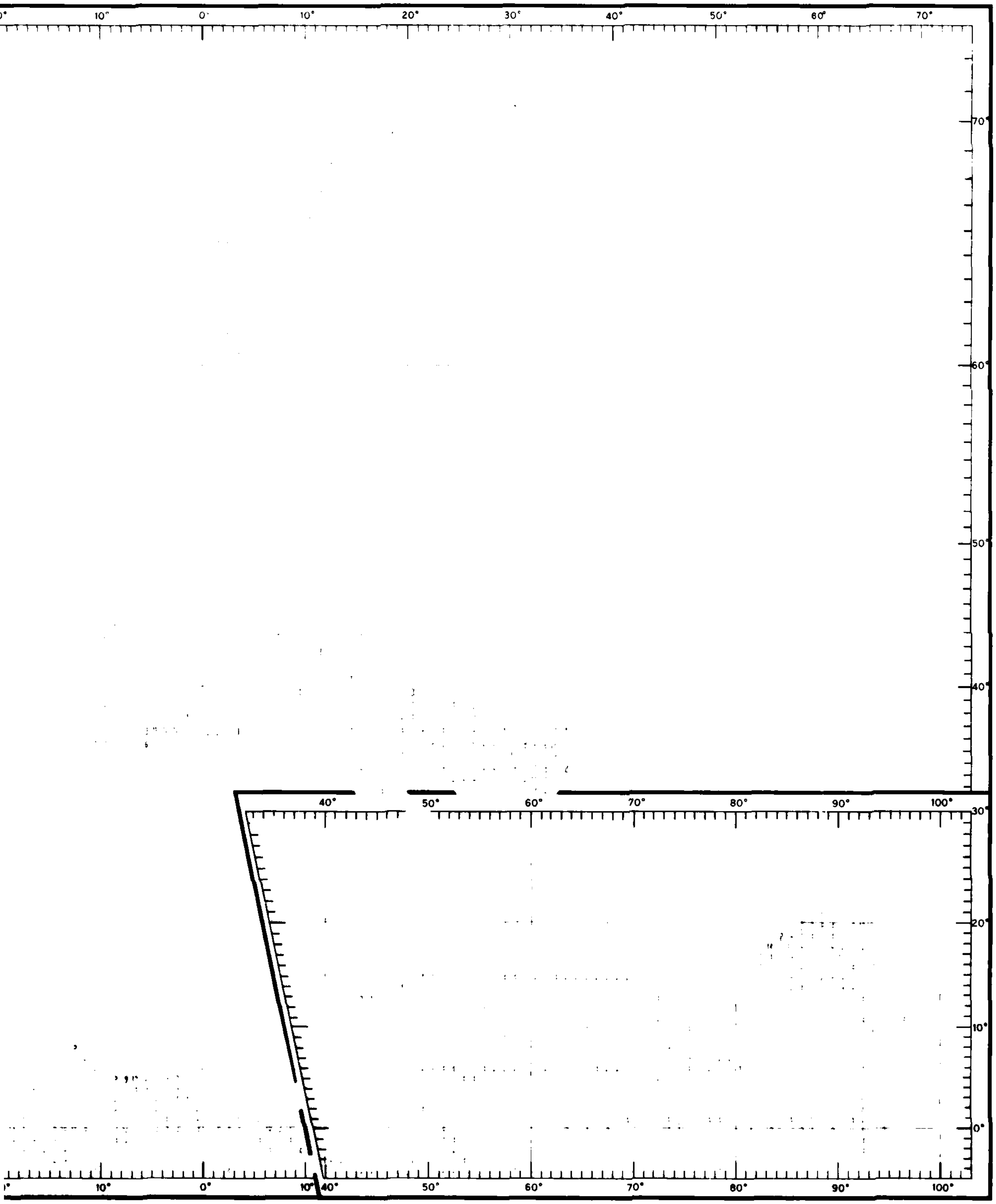


FIGURE 53. APRIL DATA DISTRIBUTION OF TEMPERATURES AT 492 FT (150 M)



IBUTION OF TEMPERATURES AT 492 FT (150 M)

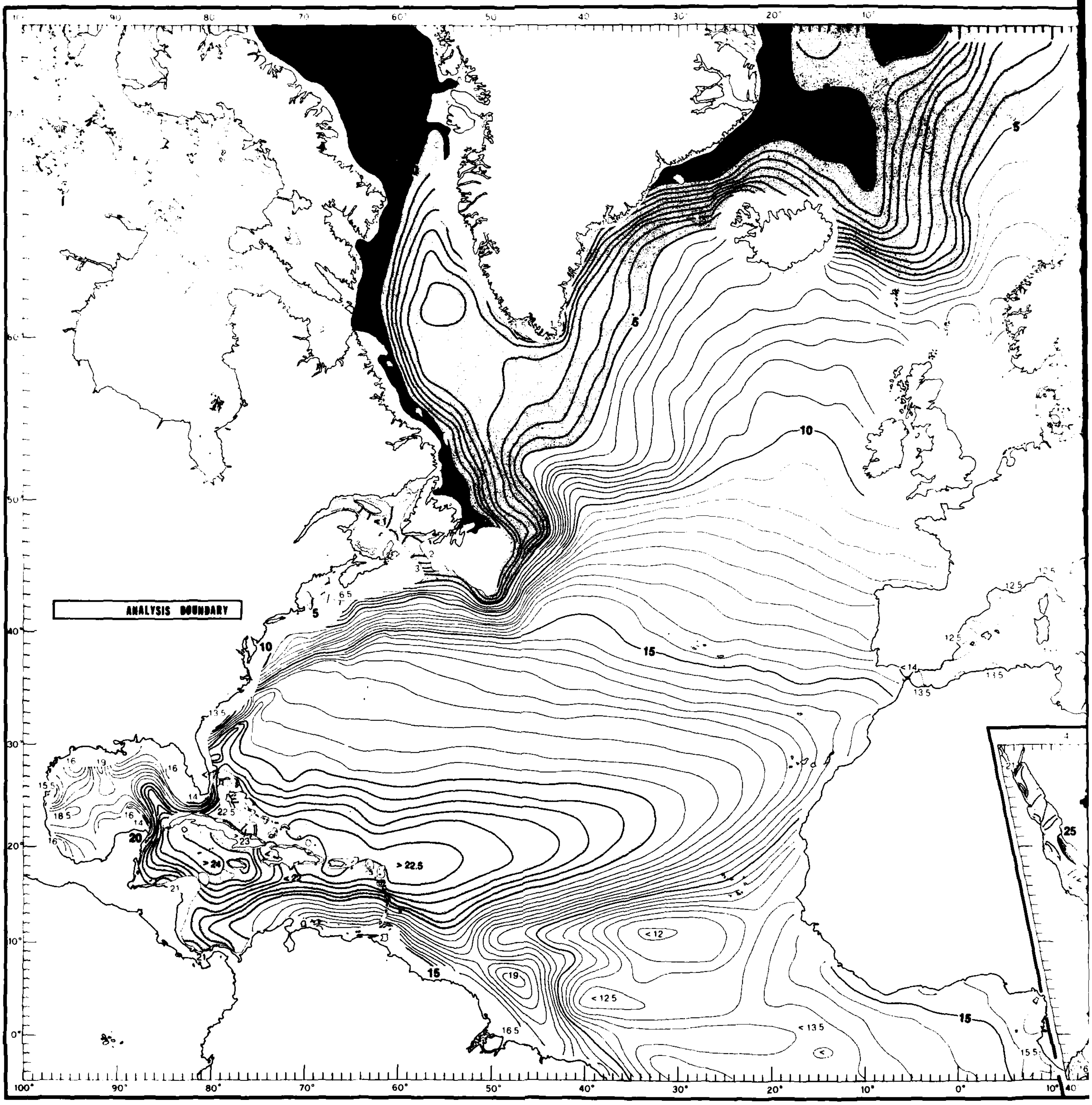
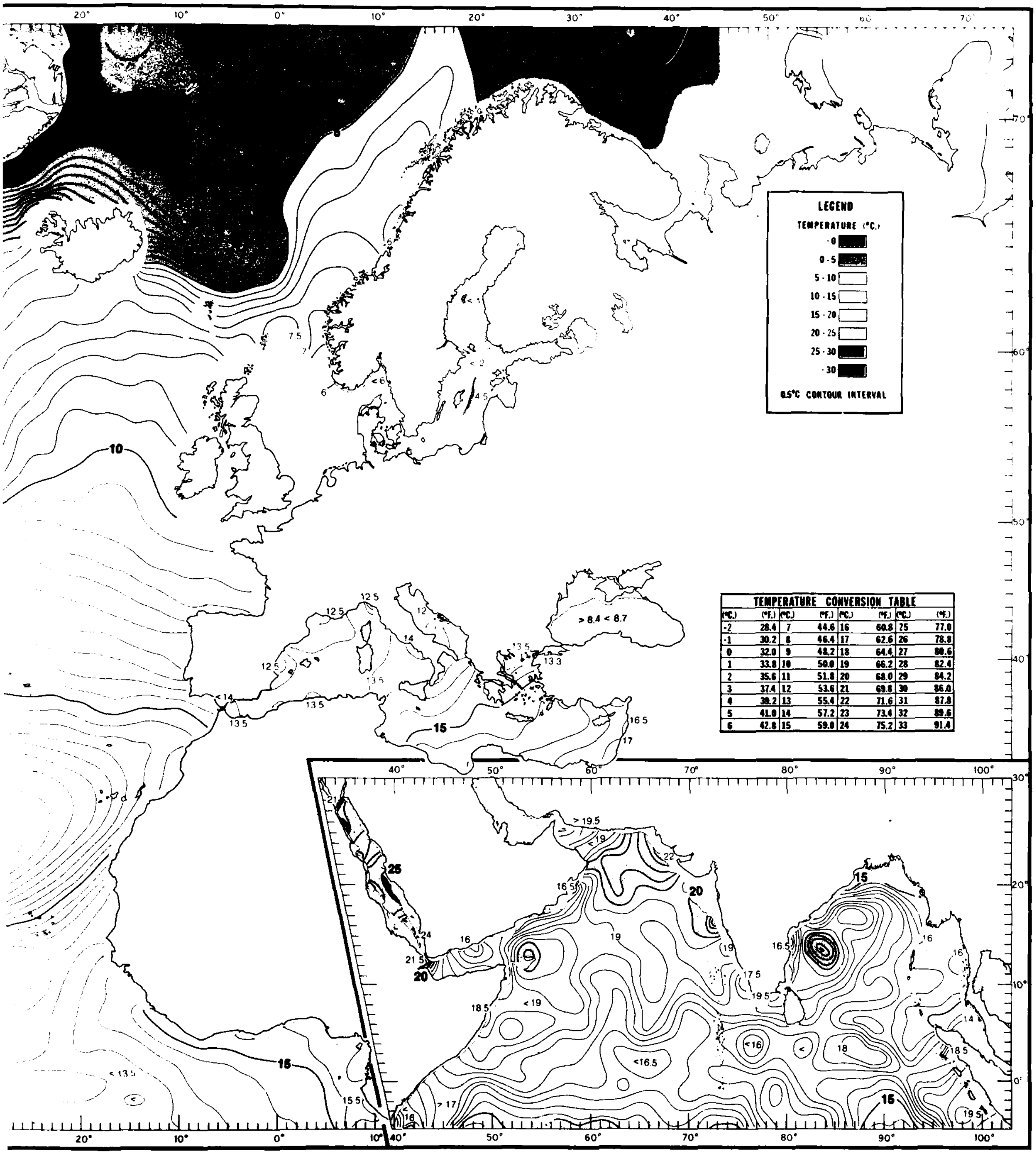


FIGURE 54. APRIL MEAN TEMPERATURES AT 492 FT (150 M)



TEMPERATURE CONVERSION TABLE							
(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

APRIL MEAN TEMPERATURES AT 492 FT (150 M)

1 2

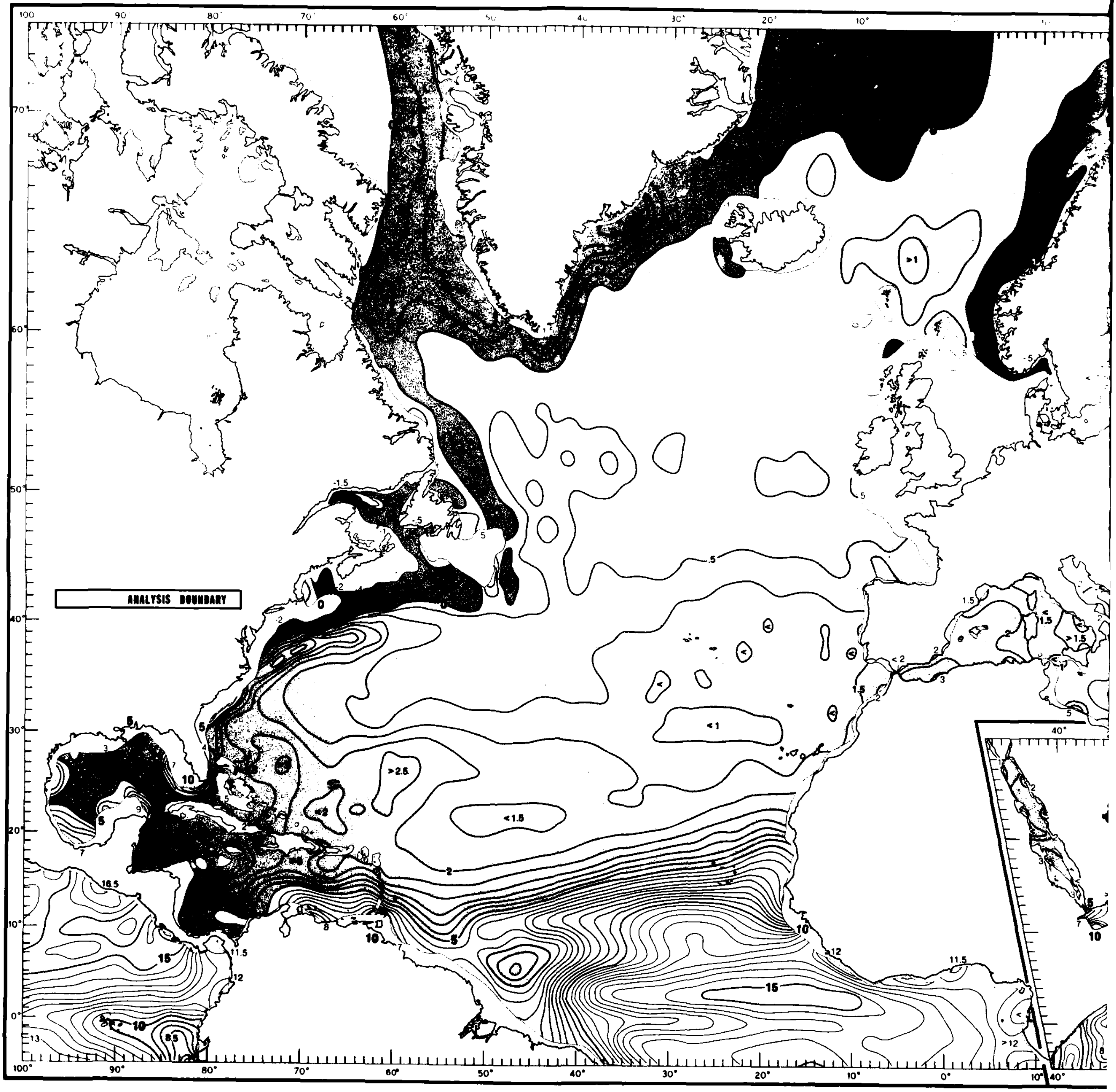
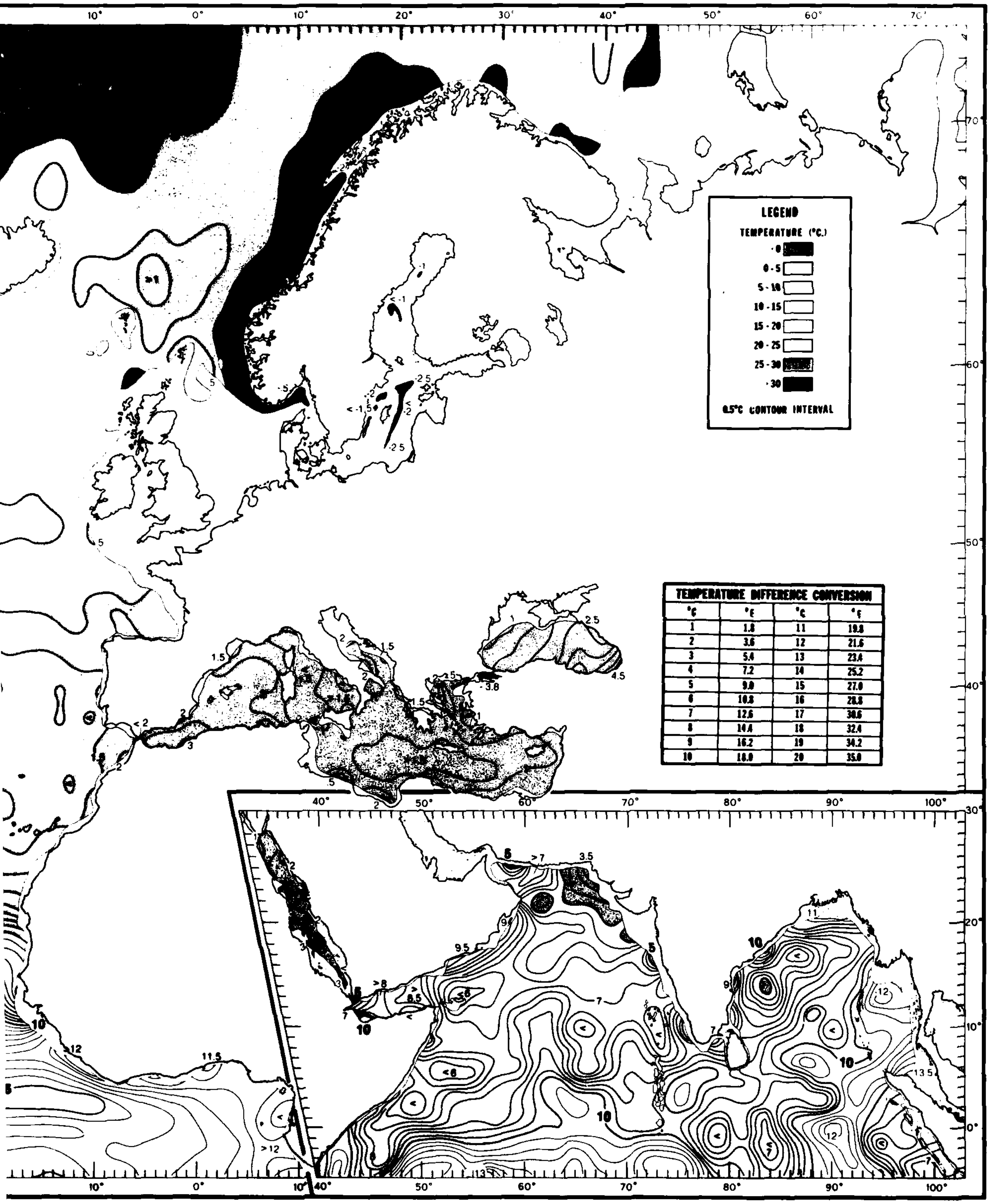


FIGURE 55. APRIL TEMPERATURE DIFFERENCE BETWEEN THE SURFACE AND 400 FT (T_0



TEMPERATURE DIFFERENCE CONVERSION			
°C	°F	°C	°F
1	1.8	11	19.8
2	3.6	12	21.6
3	5.4	13	23.4
4	7.2	14	25.2
5	9.0	15	27.0
6	10.8	16	28.8
7	12.6	17	30.6
8	14.4	18	32.4
9	16.2	19	34.2
10	18.0	20	36.0

RENCE BETWEEN THE SURFACE AND 400 FT (T_0-T_{400})

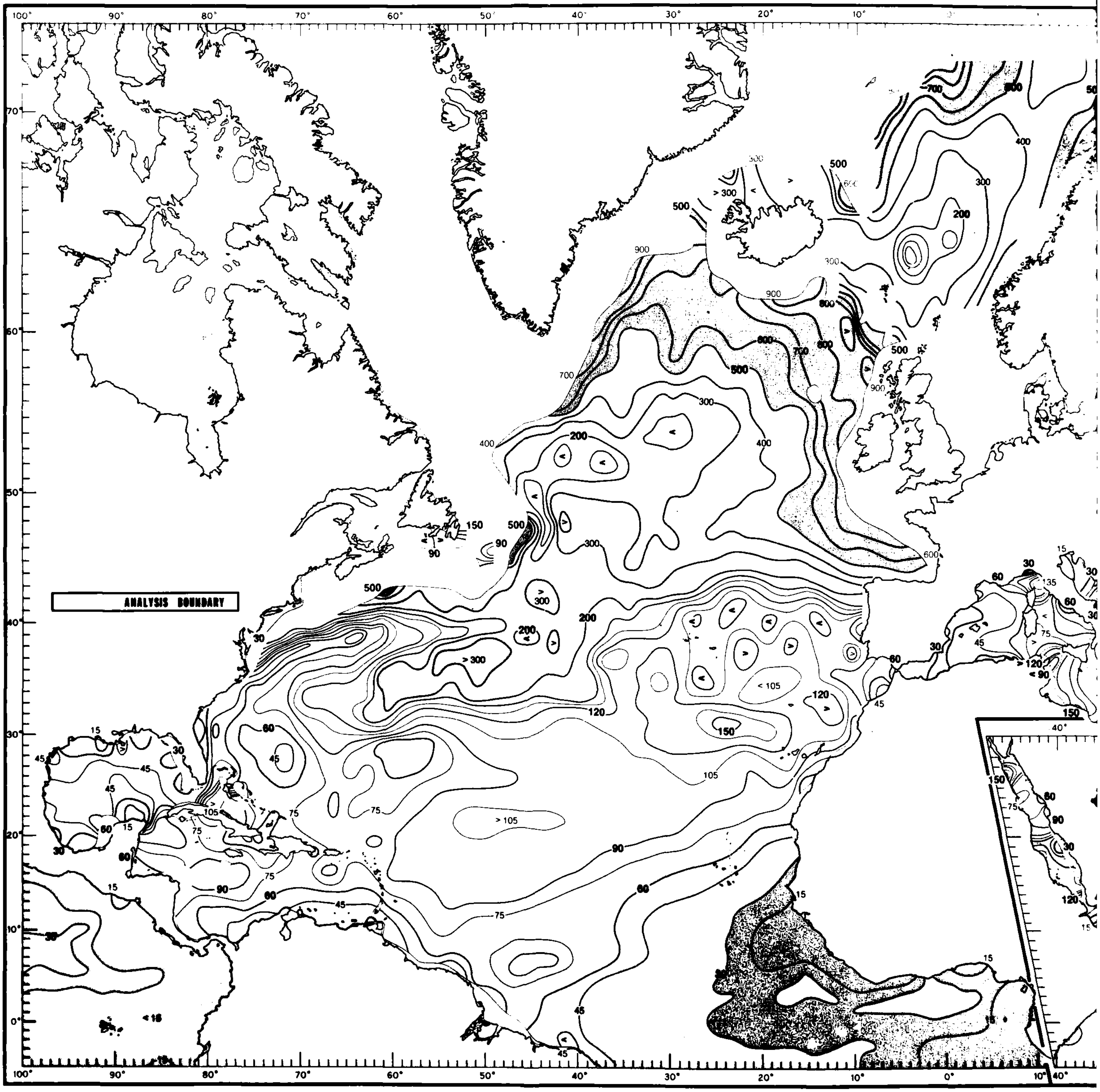
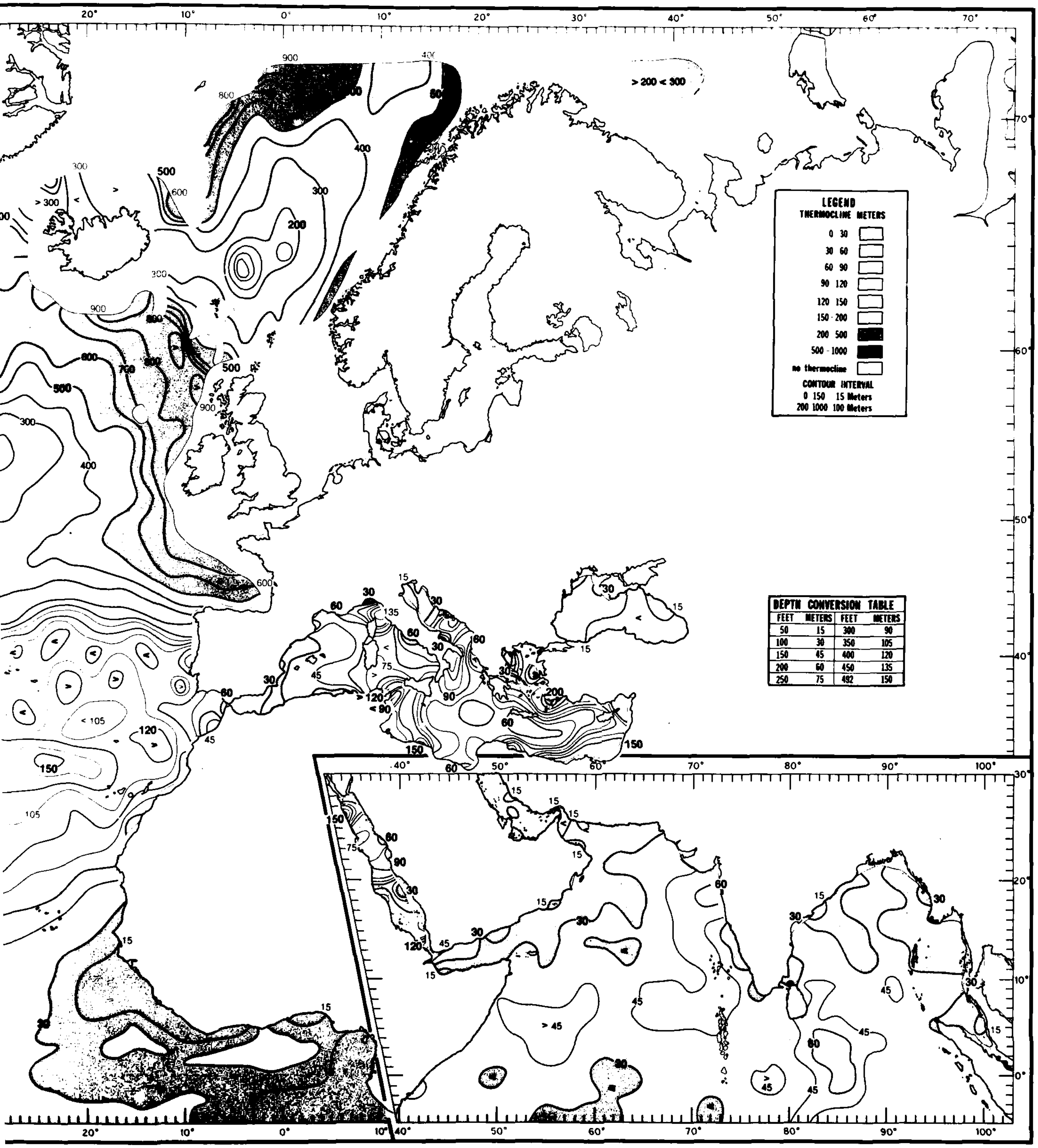


FIGURE 56. APRIL MEAN DEPTHS TO THE TOP OF THE THERMOCLINE



DEPTH CONVERSION TABLE			
FEET	METERS	FEET	METERS
50	15	300	90
100	30	350	105
150	45	400	120
200	60	450	135
250	75	492	150

APRIL MEAN DEPTHS TO THE TOP OF THE THERMOCLINE

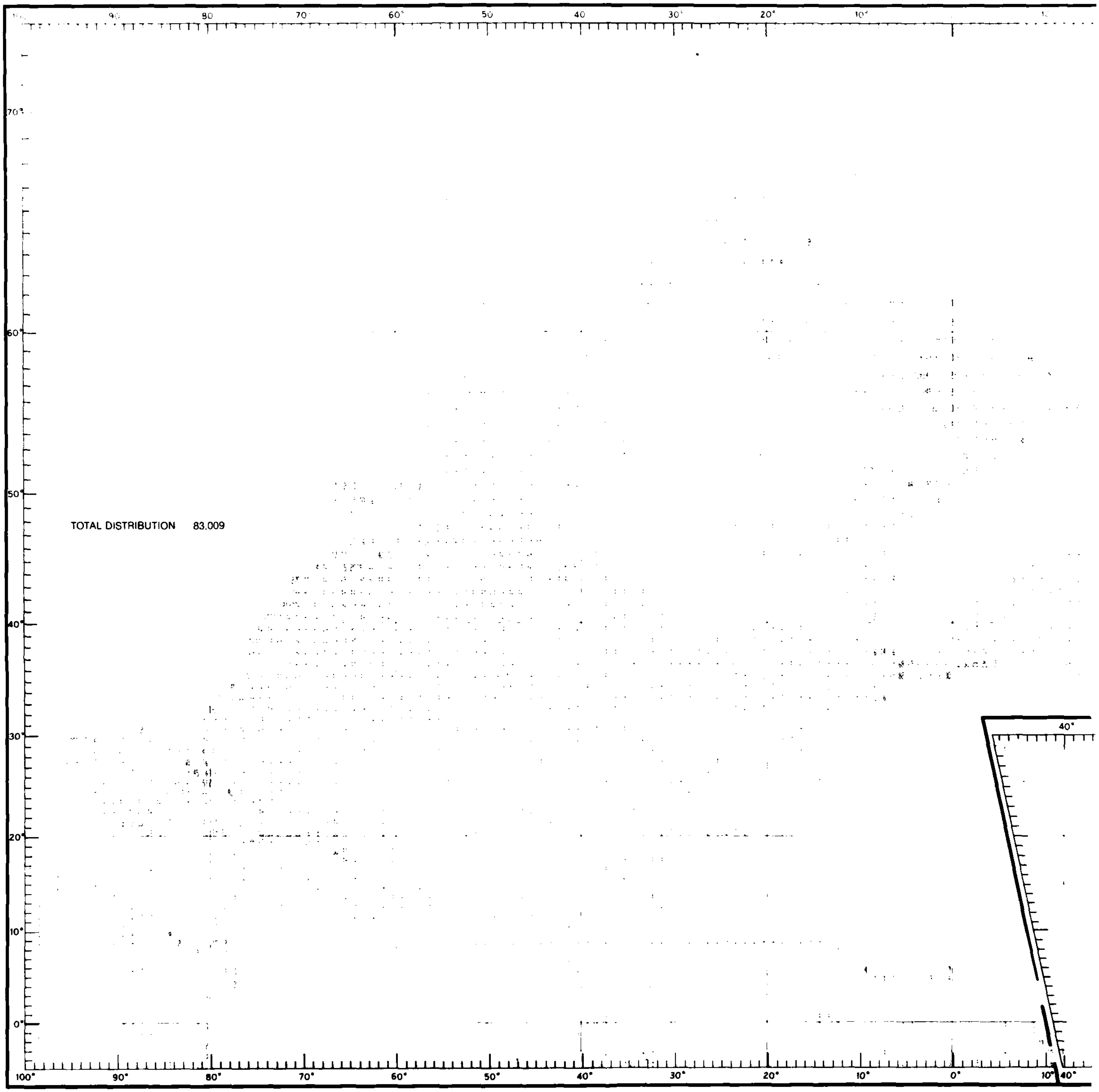
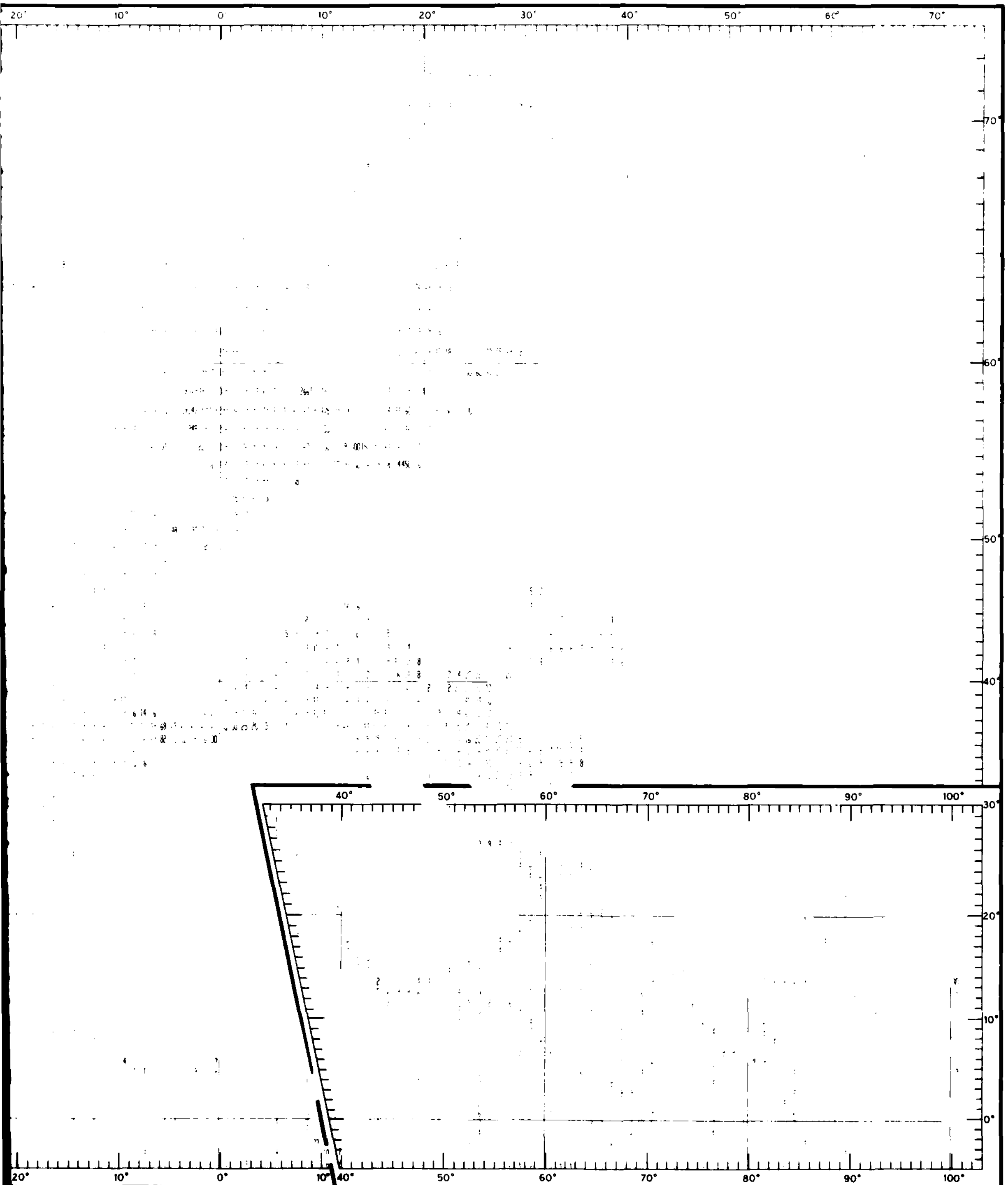


FIGURE 57. MAY DATA DISTRIBUTION OF TEMPERATURES AT THE SURFACE



IBUTION OF TEMPERATURES AT THE SURFACE

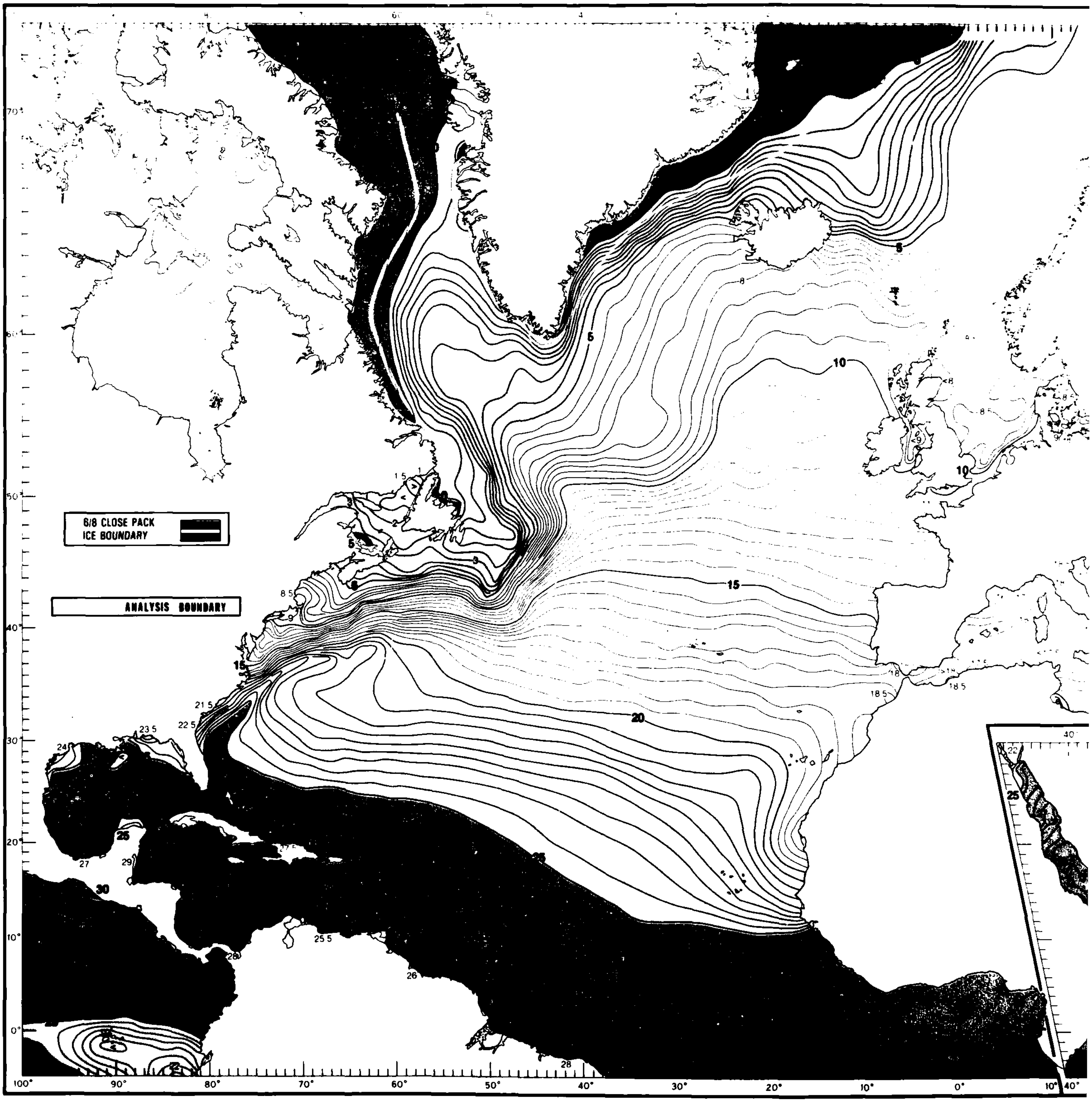
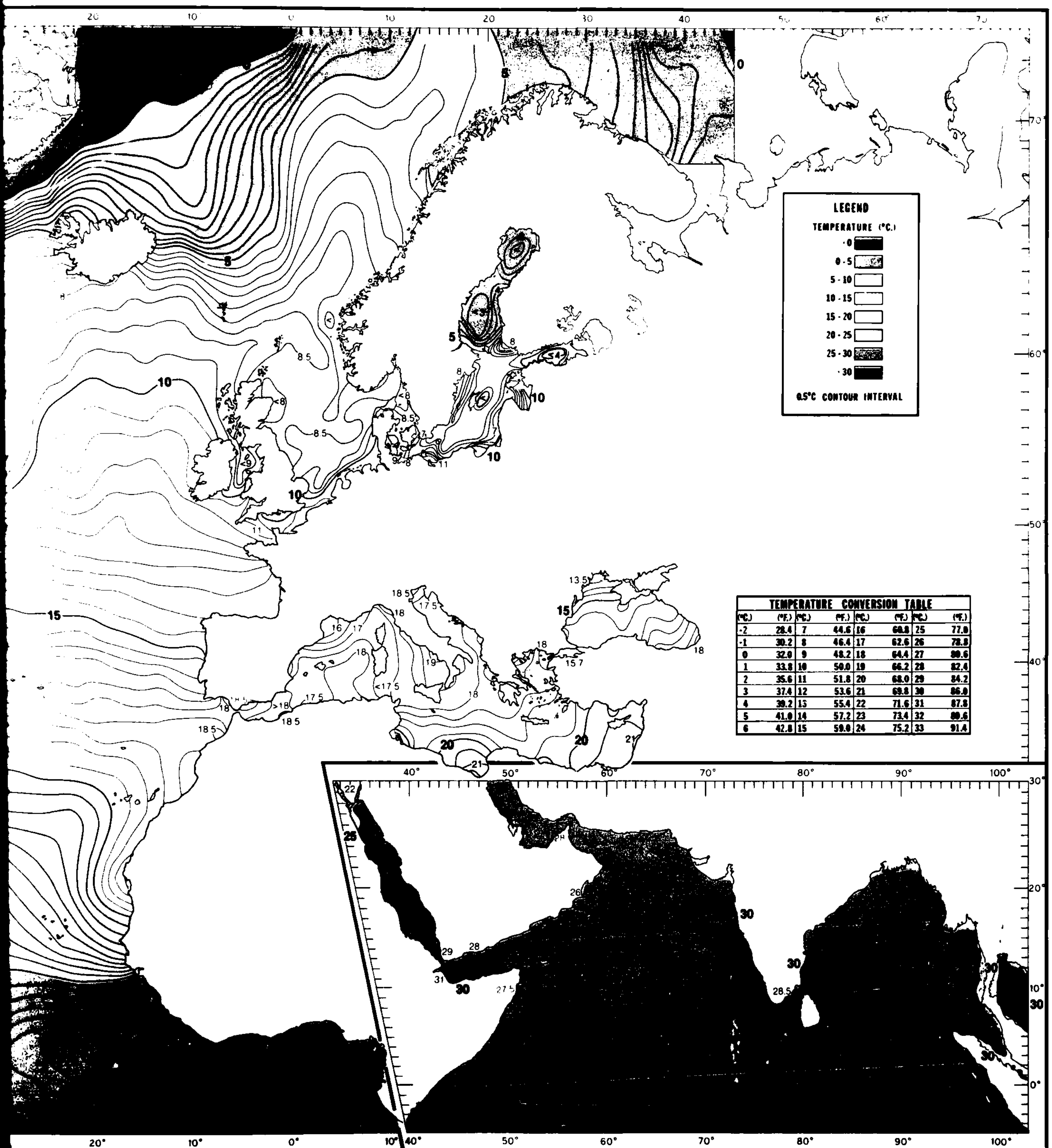


FIGURE 58. MAY MEAN TEMPERATURES AT THE SURFACE



TEMPERATURE CONVERSION TABLE							
(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

MAY MEAN TEMPERATURES AT THE SURFACE

2

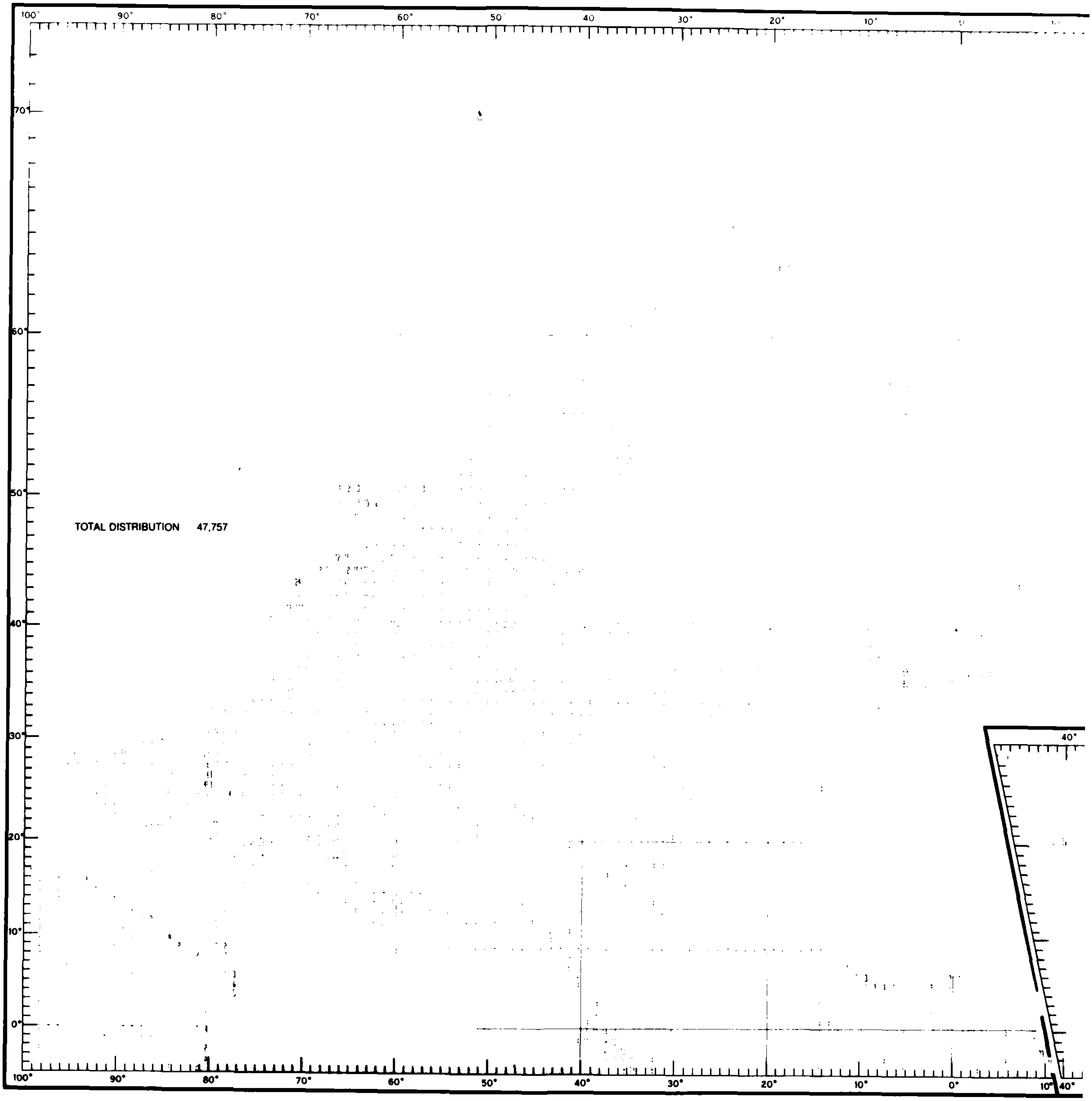
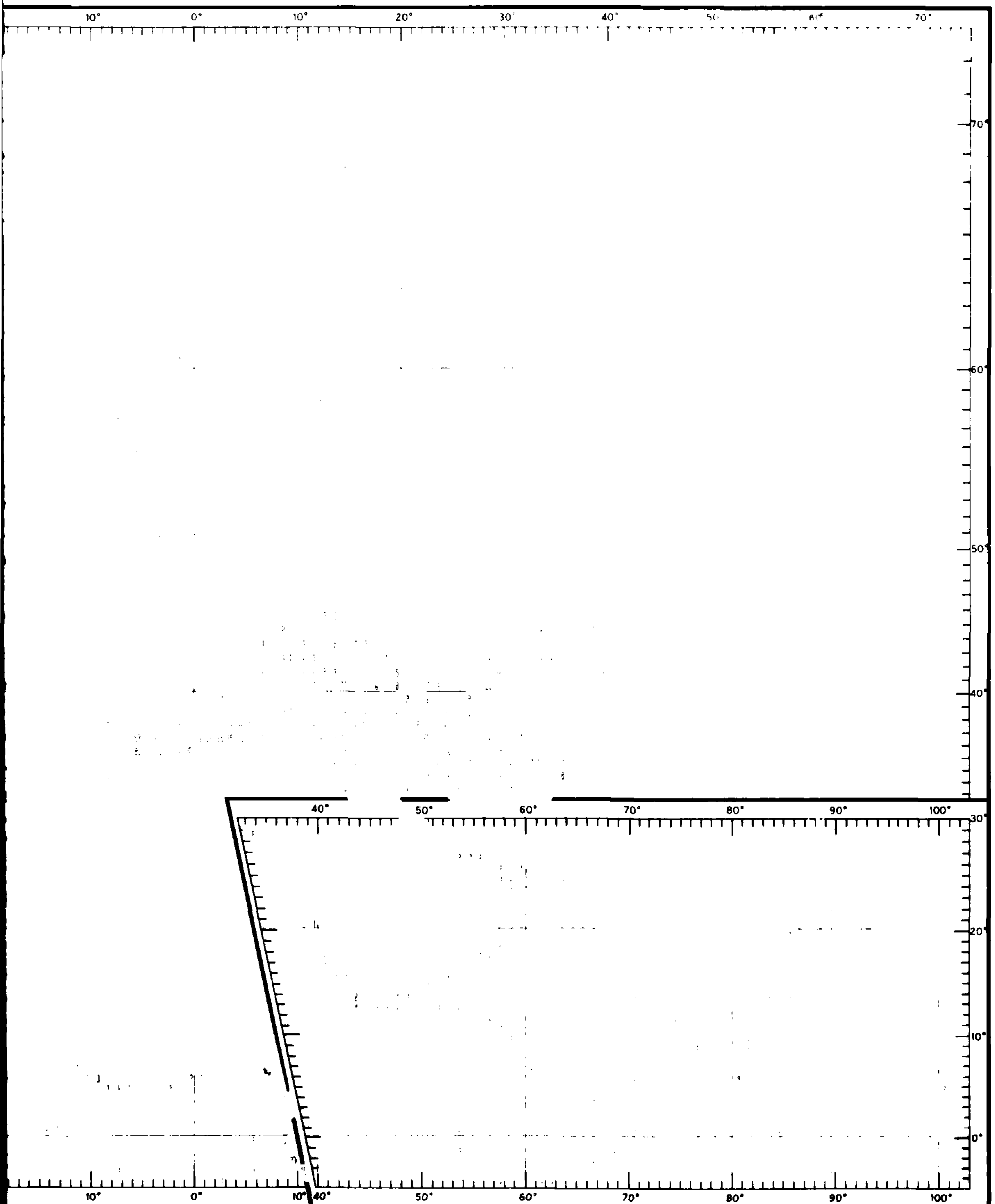


FIGURE 59. MAY DATA DISTRIBUTION OF TEMPERATURES AT 100 FT (30 M)



UTION OF TEMPERATURES AT 100 FT (30 M)

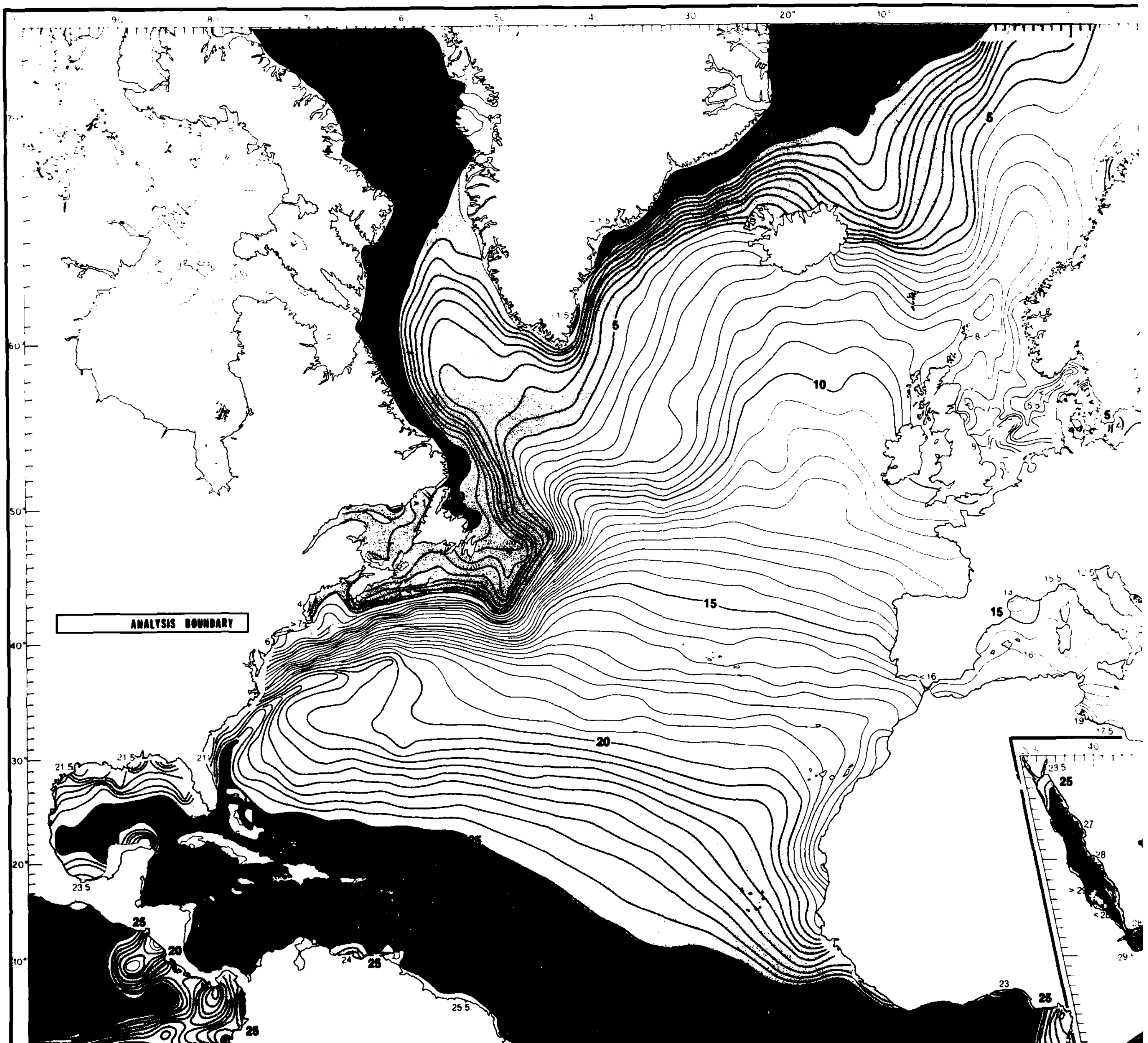
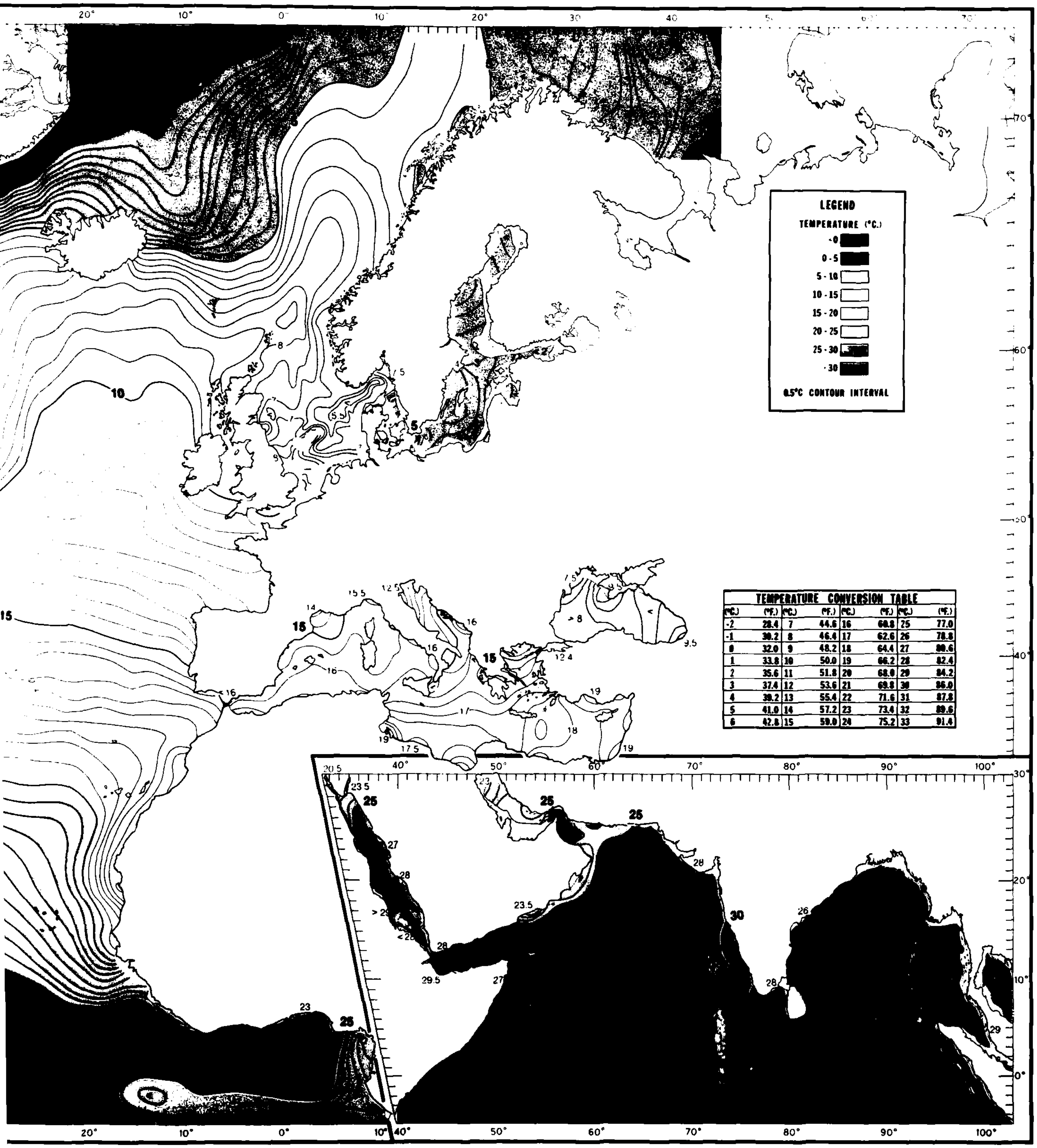


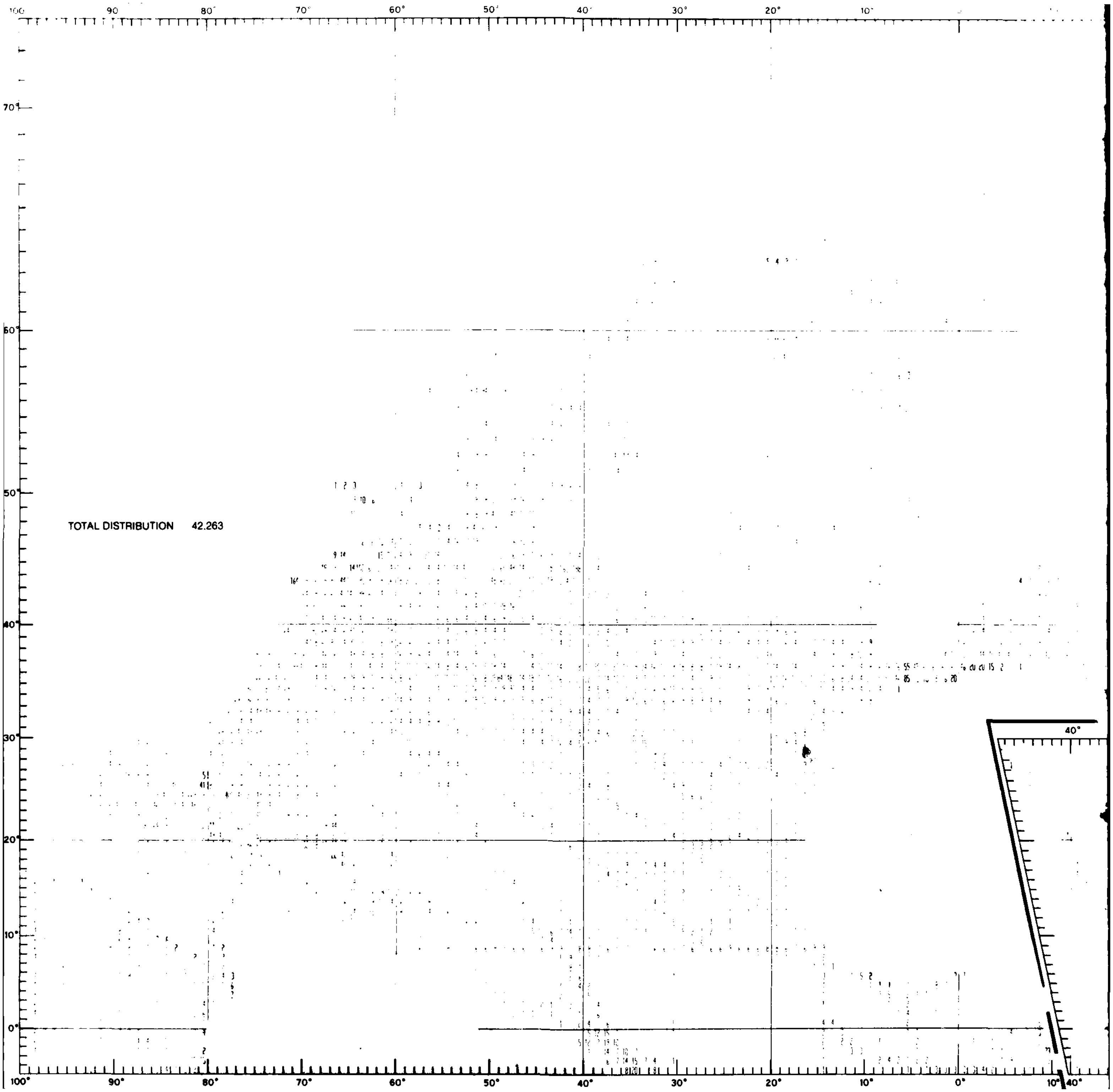
FIGURE 60. MAY MEAN TEMPERATURES AT 100 FT (30 M)

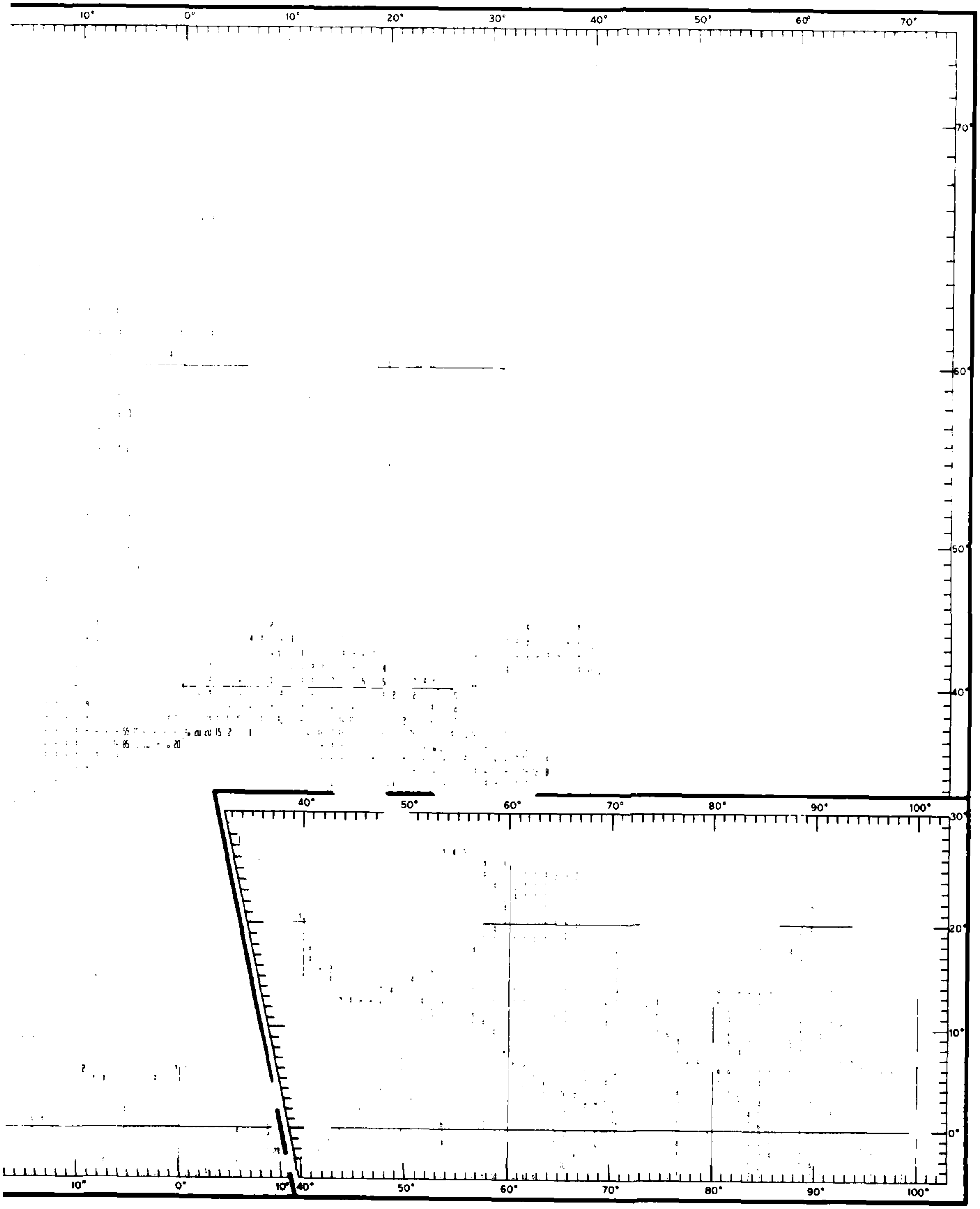


TEMPERATURE CONVERSION TABLE

(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

60. MAY MEAN TEMPERATURES AT 100 FT (30 M)


TOTAL DISTRIBUTION 42.263



TION OF TEMPERATURES AT 200 FT (60 M)

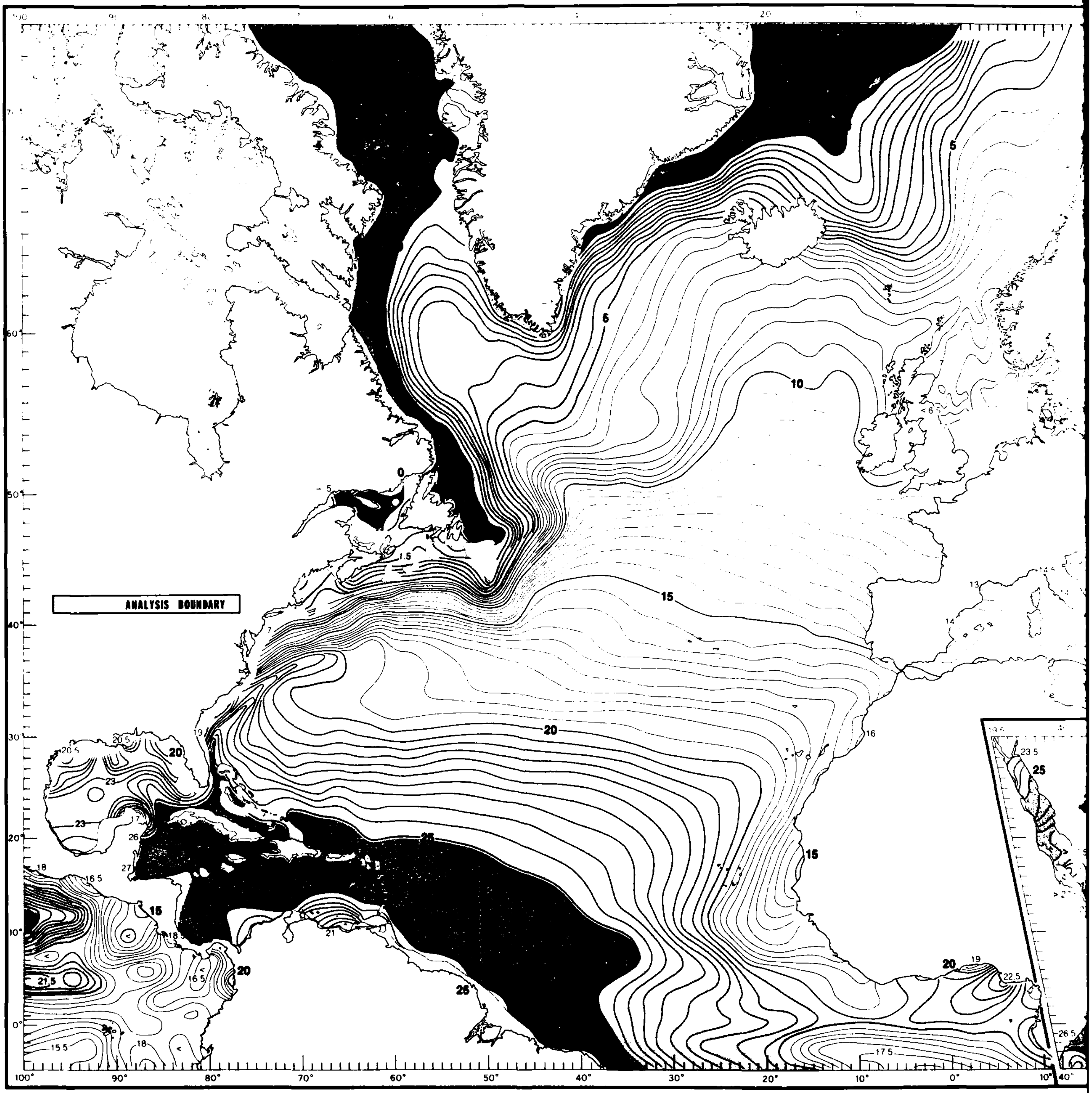
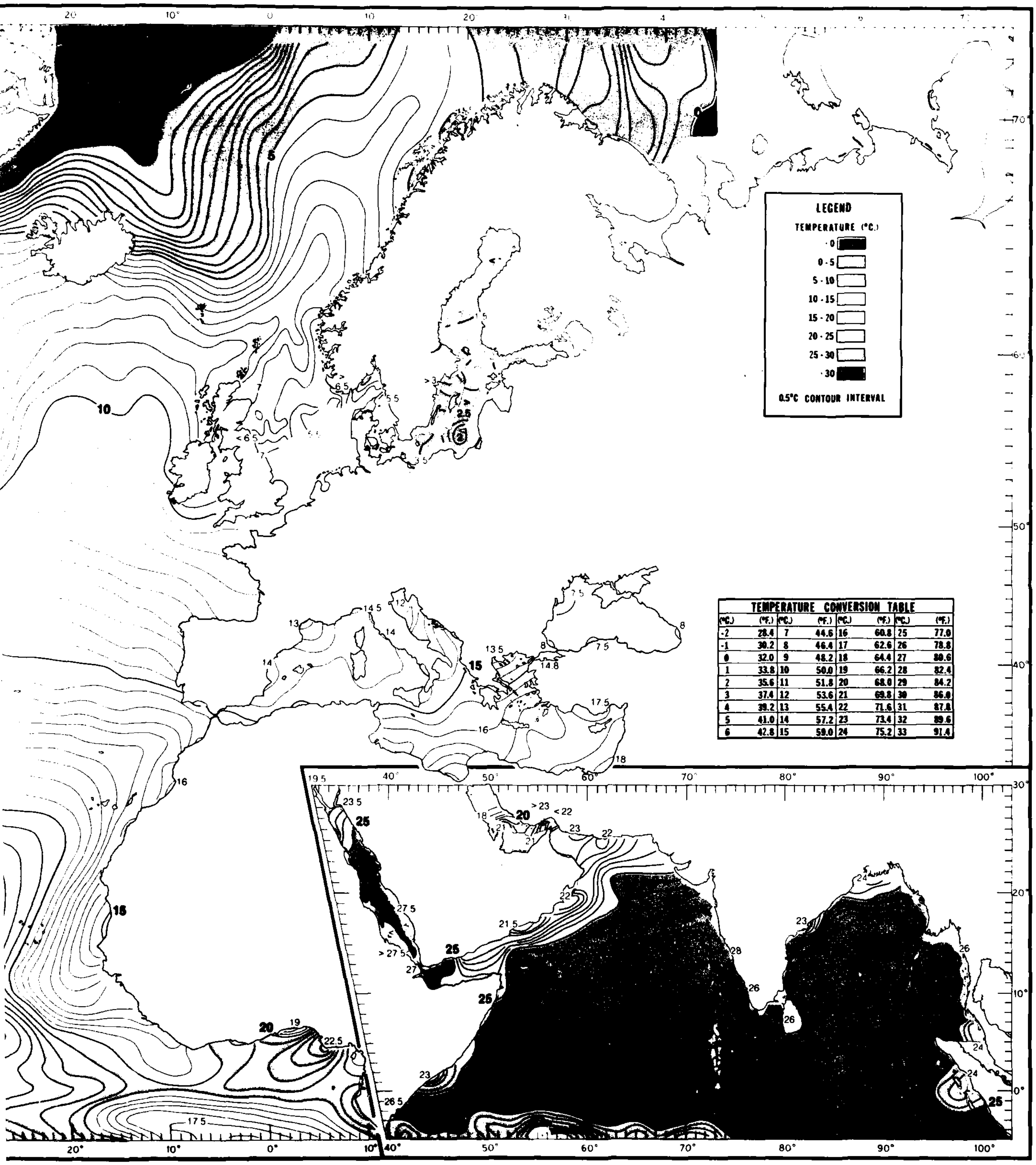


FIGURE 62. MAY MEAN TEMPERATURES AT 200 FT (60 M)



TEMPERATURE CONVERSION TABLE

(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

12. MAY MEAN TEMPERATURES AT 200 FT (60 M)

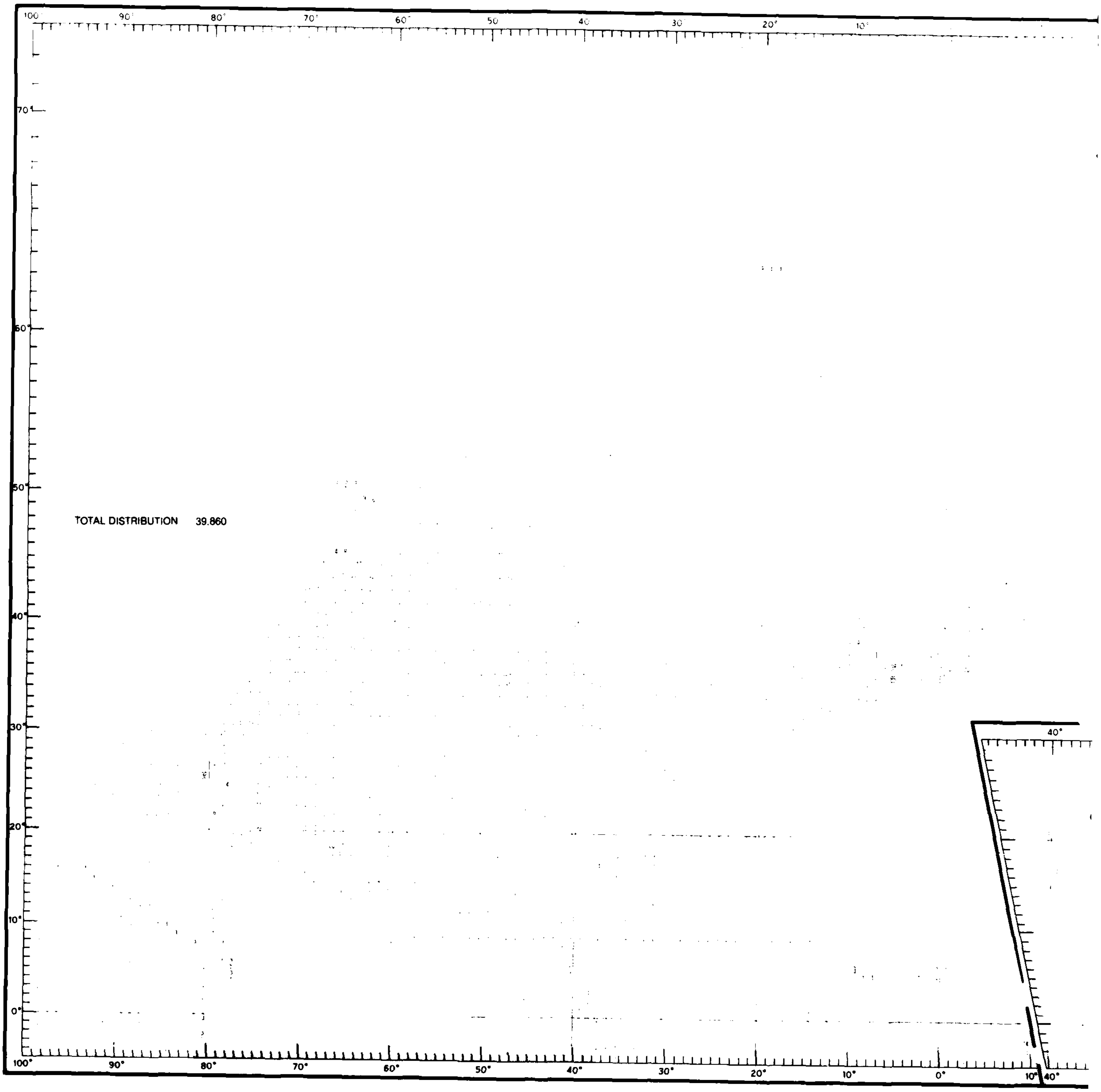
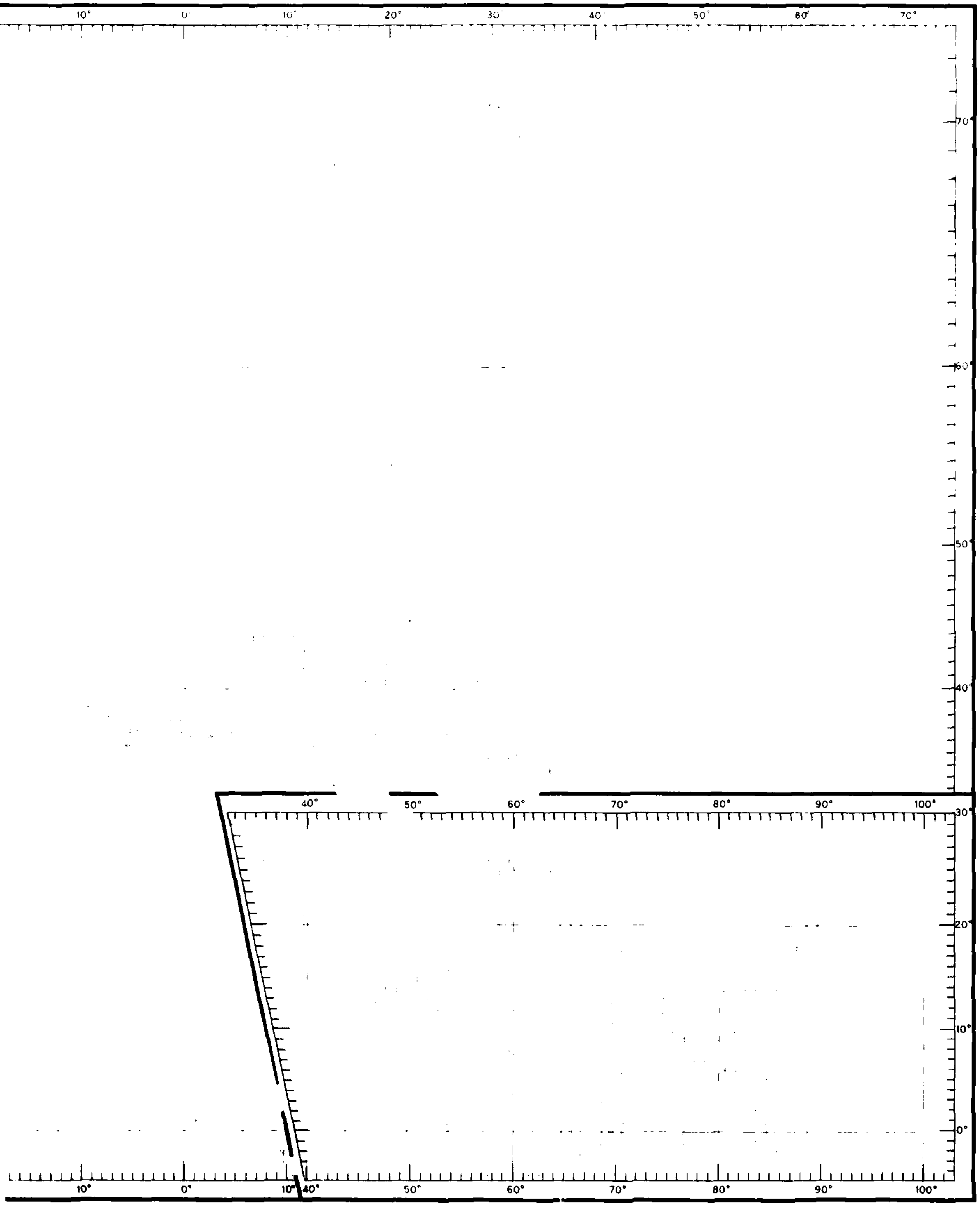


FIGURE 63. MAY DATA DISTRIBUTION OF TEMPERATURES AT 300 FT (90 M)



TION OF TEMPERATURES AT 300 FT (90 M)

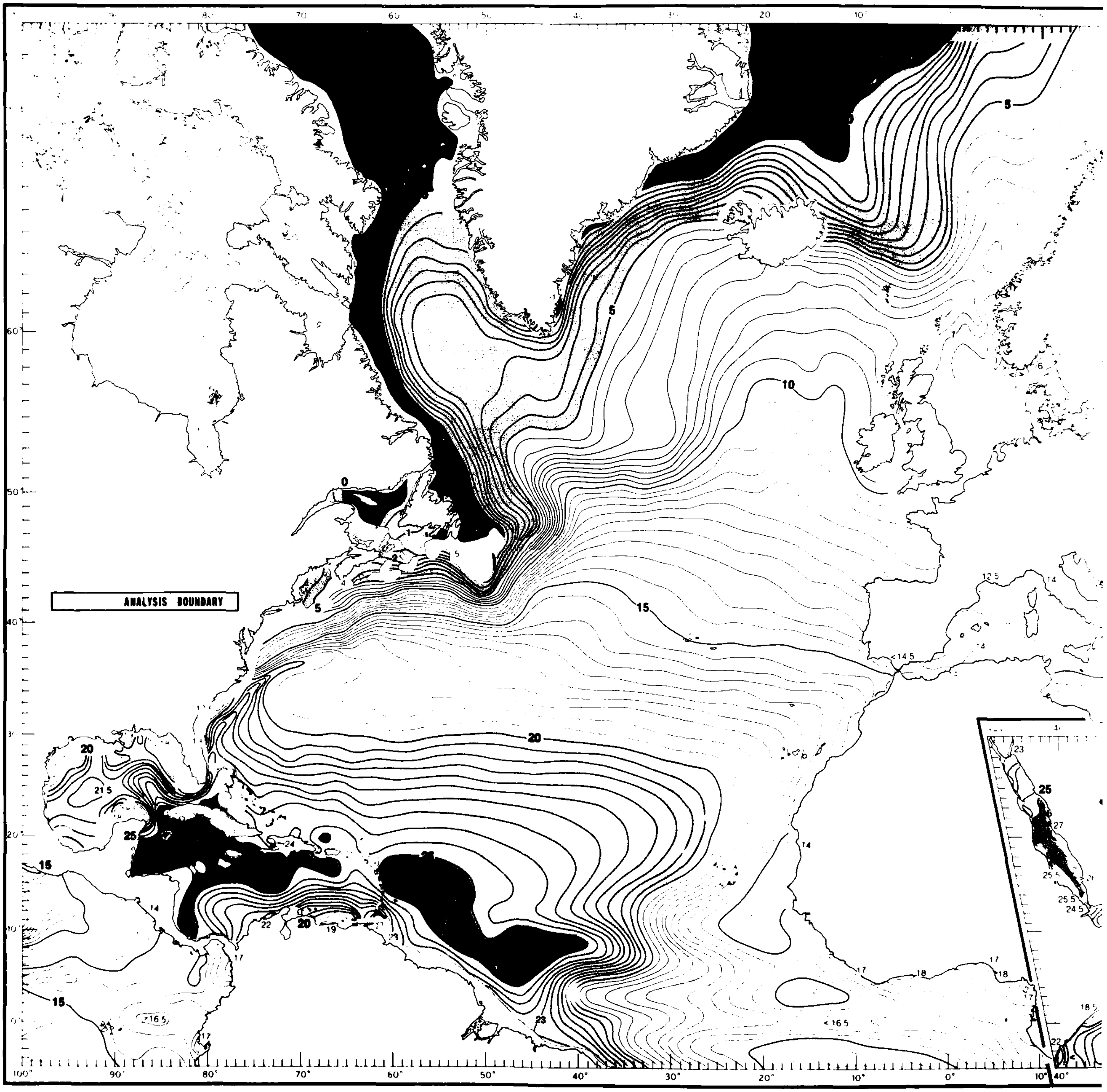
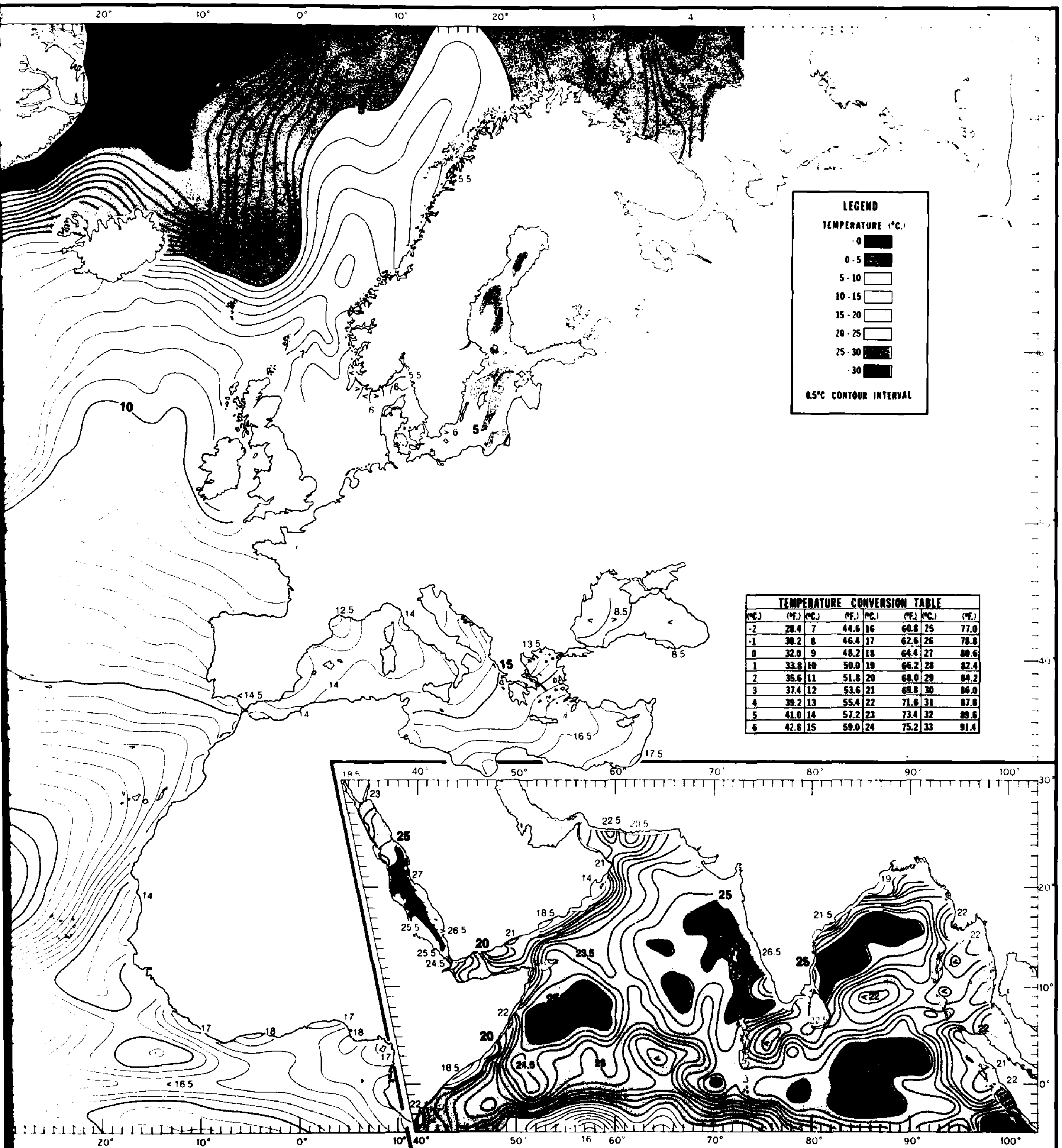


FIGURE 64. MAY MEAN TEMPERATURES AT 300 FT (90 M)



TEMPERATURE CONVERSION TABLE

(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

RE 64. MAY MEAN TEMPERATURES AT 300 FT (90 M)

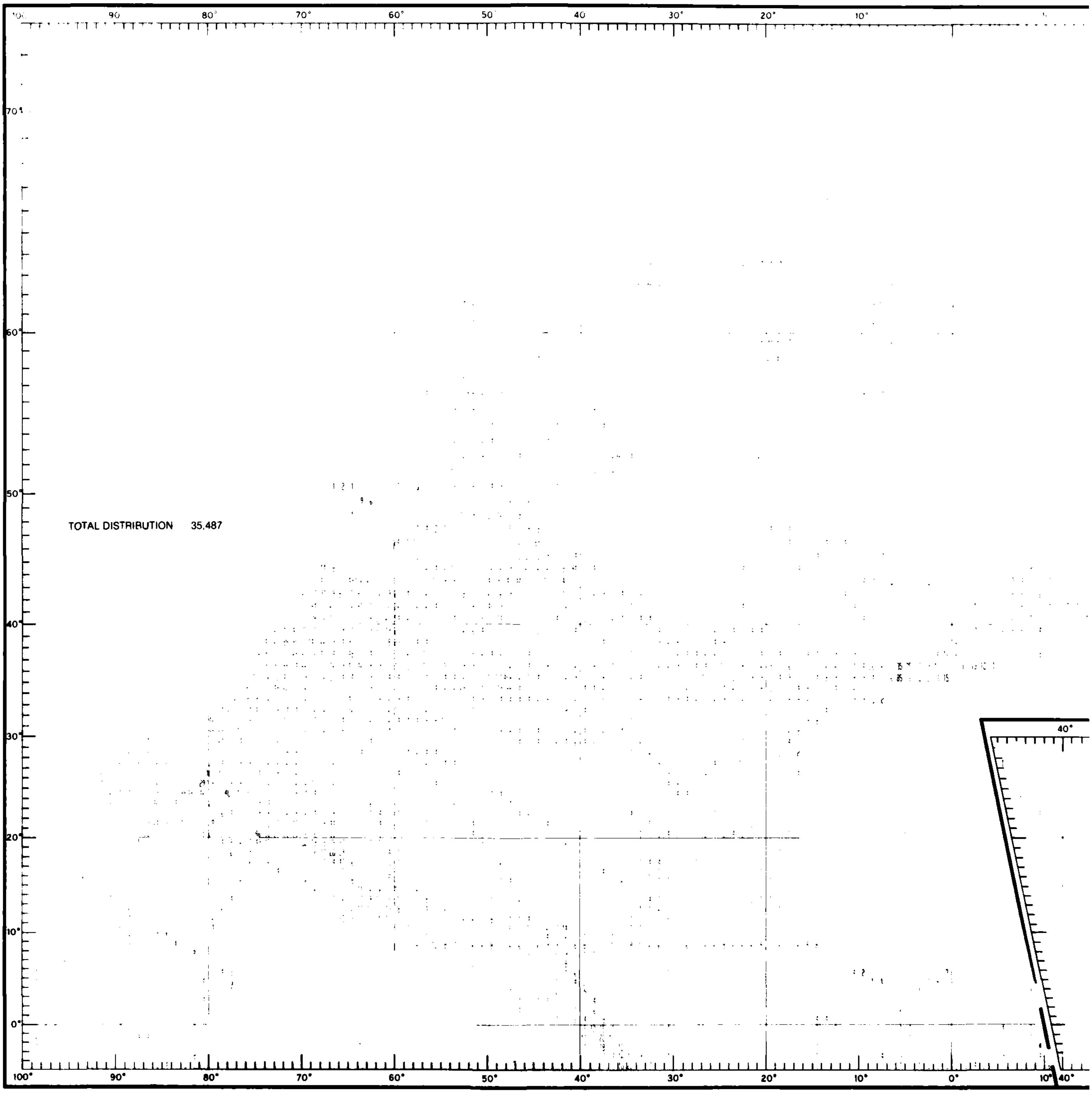
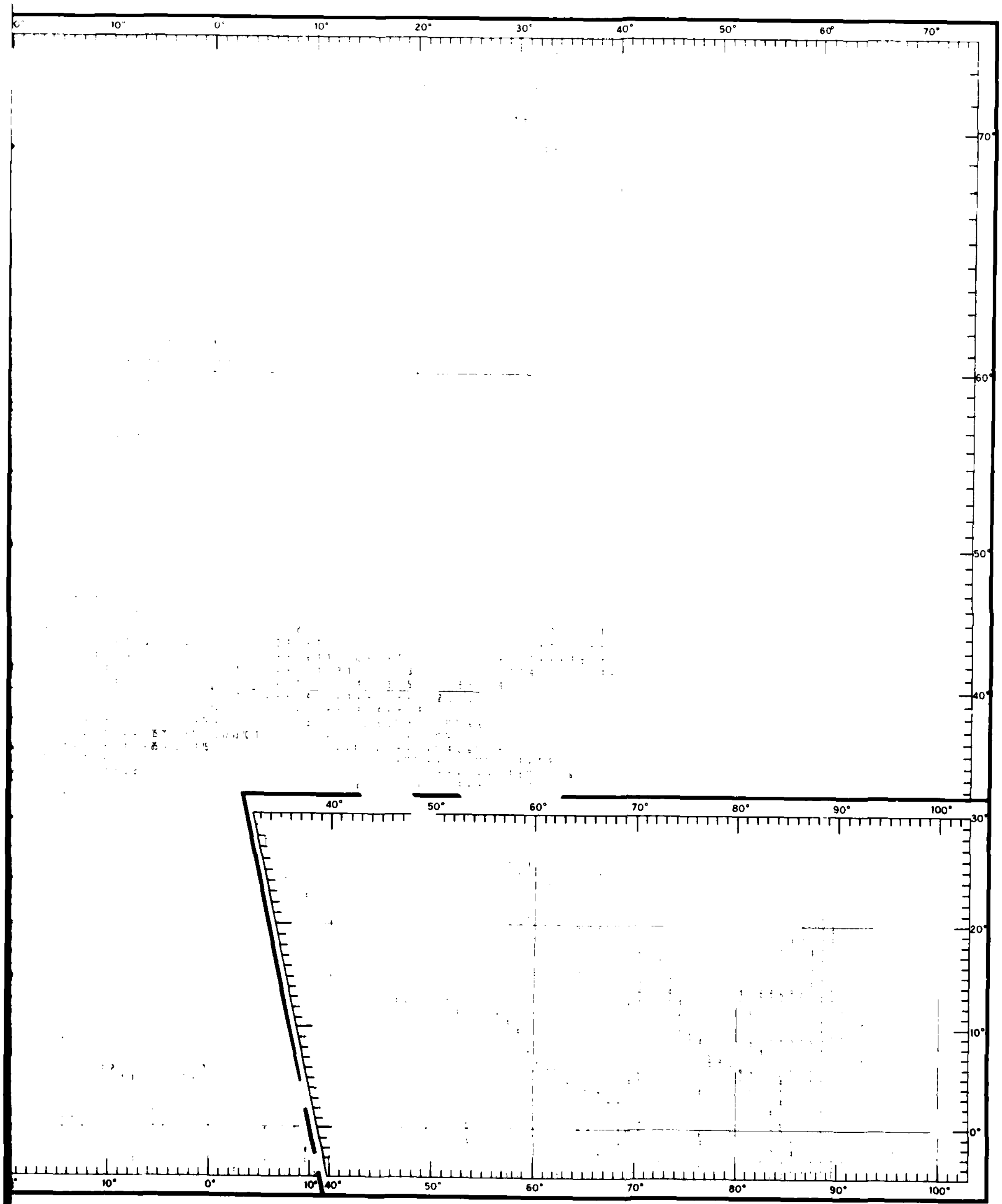


FIGURE 65. MAY DATA DISTRIBUTION OF TEMPERATURES AT 400 FT (120 M)



BUTION OF TEMPERATURES AT 400 FT (120 M)

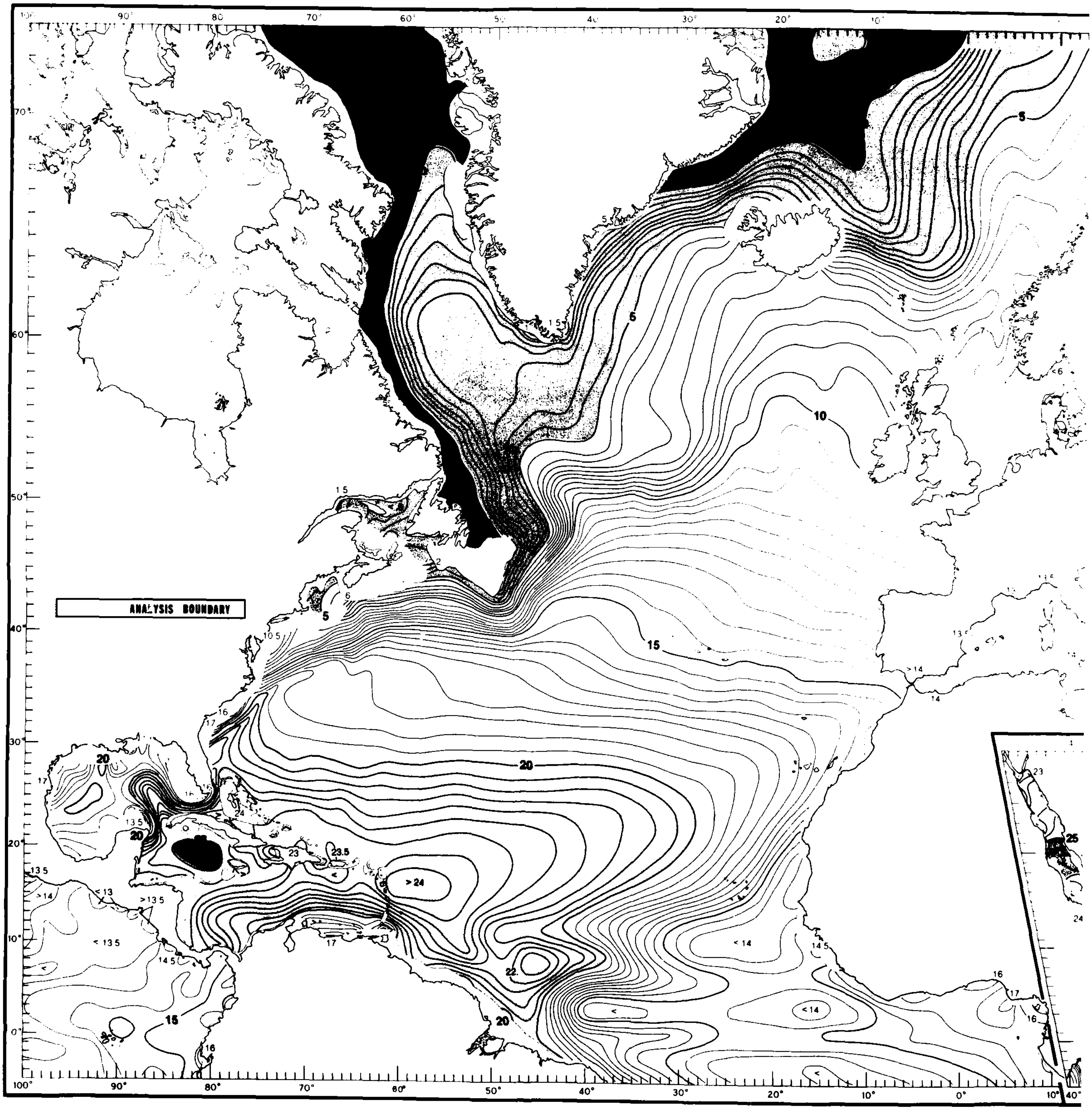
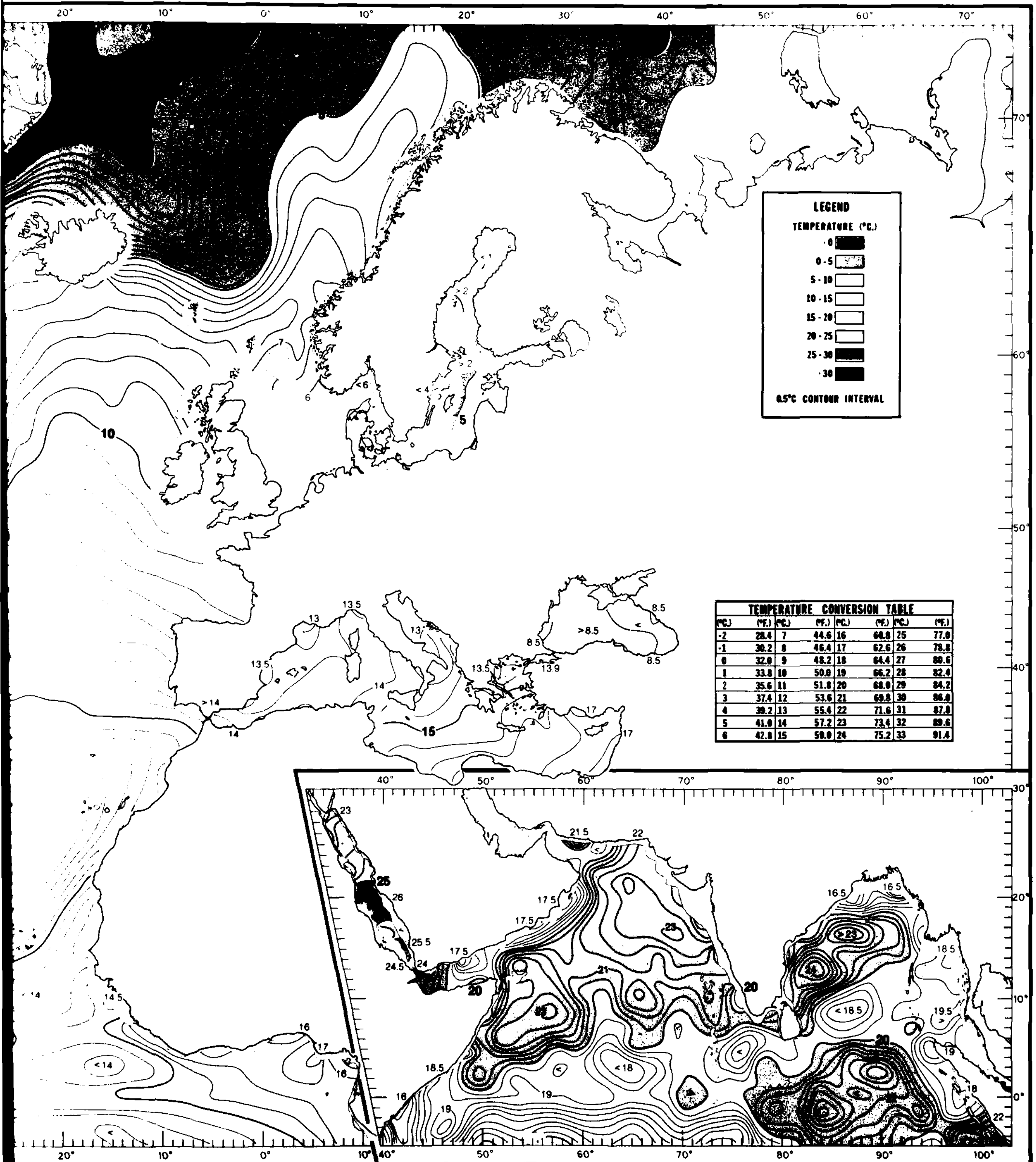


FIGURE 66. MAY MEAN TEMPERATURES AT 400 FT (120 M)



TEMPERATURE CONVERSION TABLE							
(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

MAY MEAN TEMPERATURES AT 400 FT (120 M)

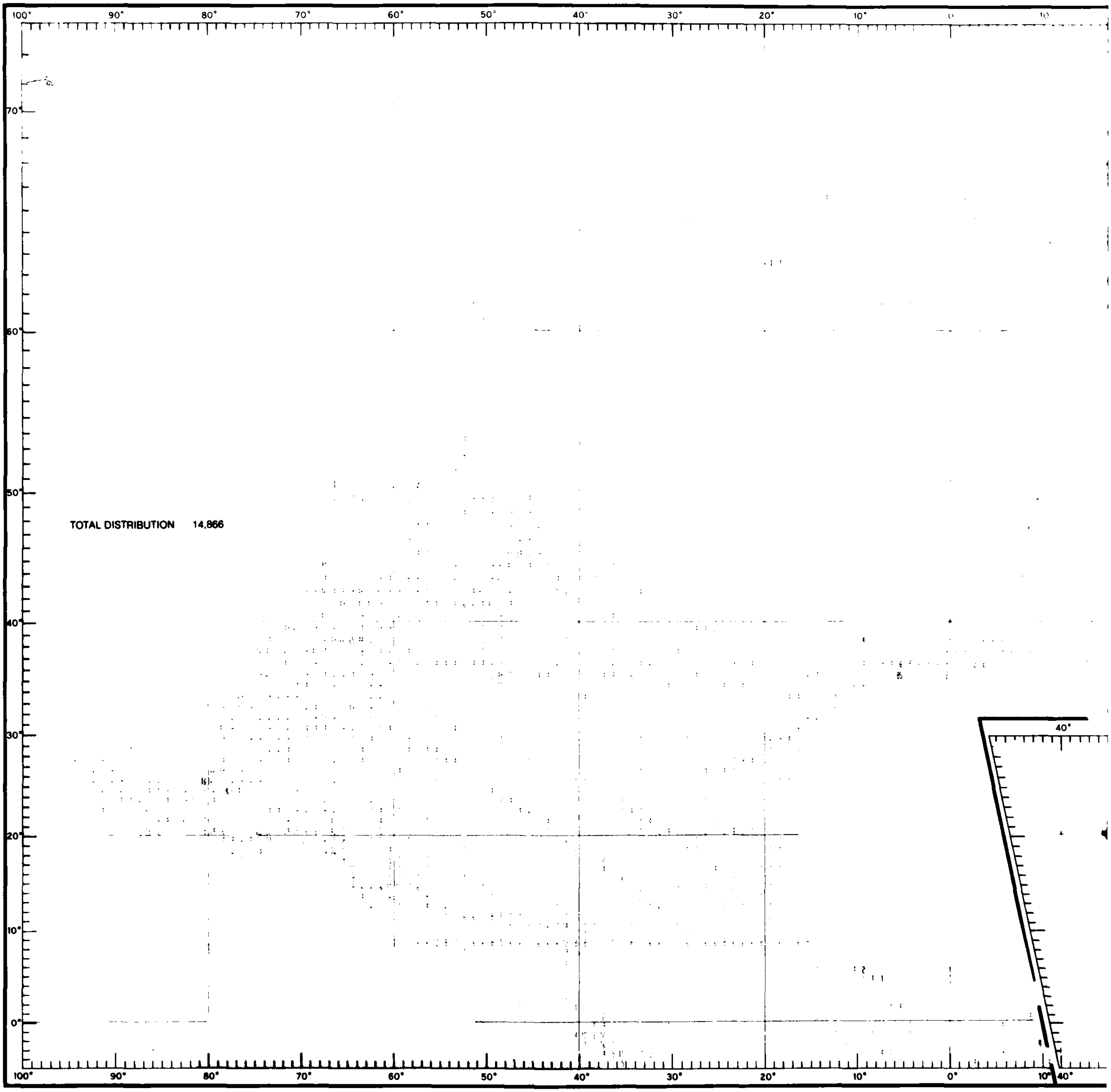
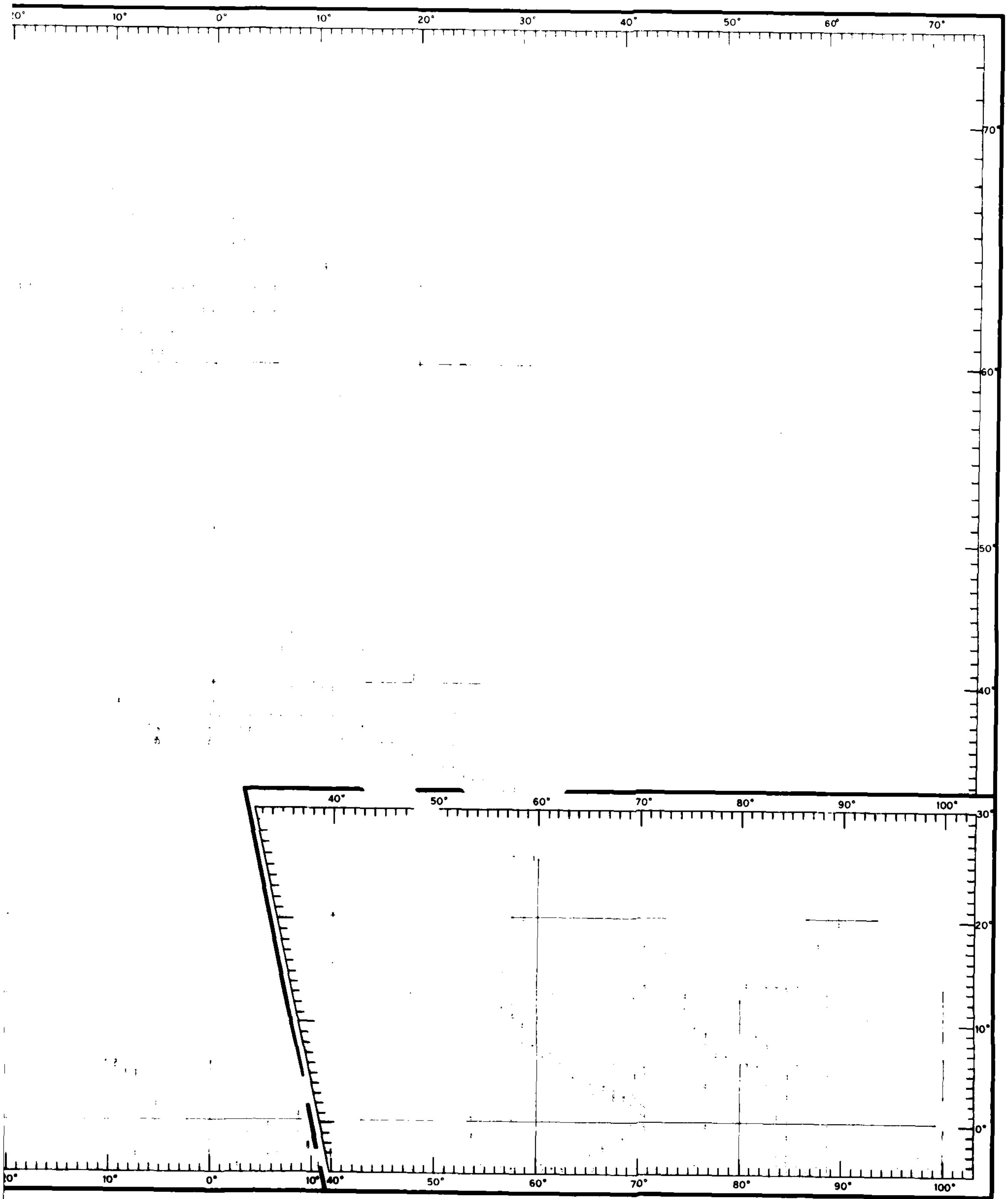


FIGURE 67. MAY DATA DISTRIBUTION OF TEMPERATURES AT 492 FT (150 M)

1



IBUTION OF TEMPERATURES AT 492 FT (150 M)

1 2

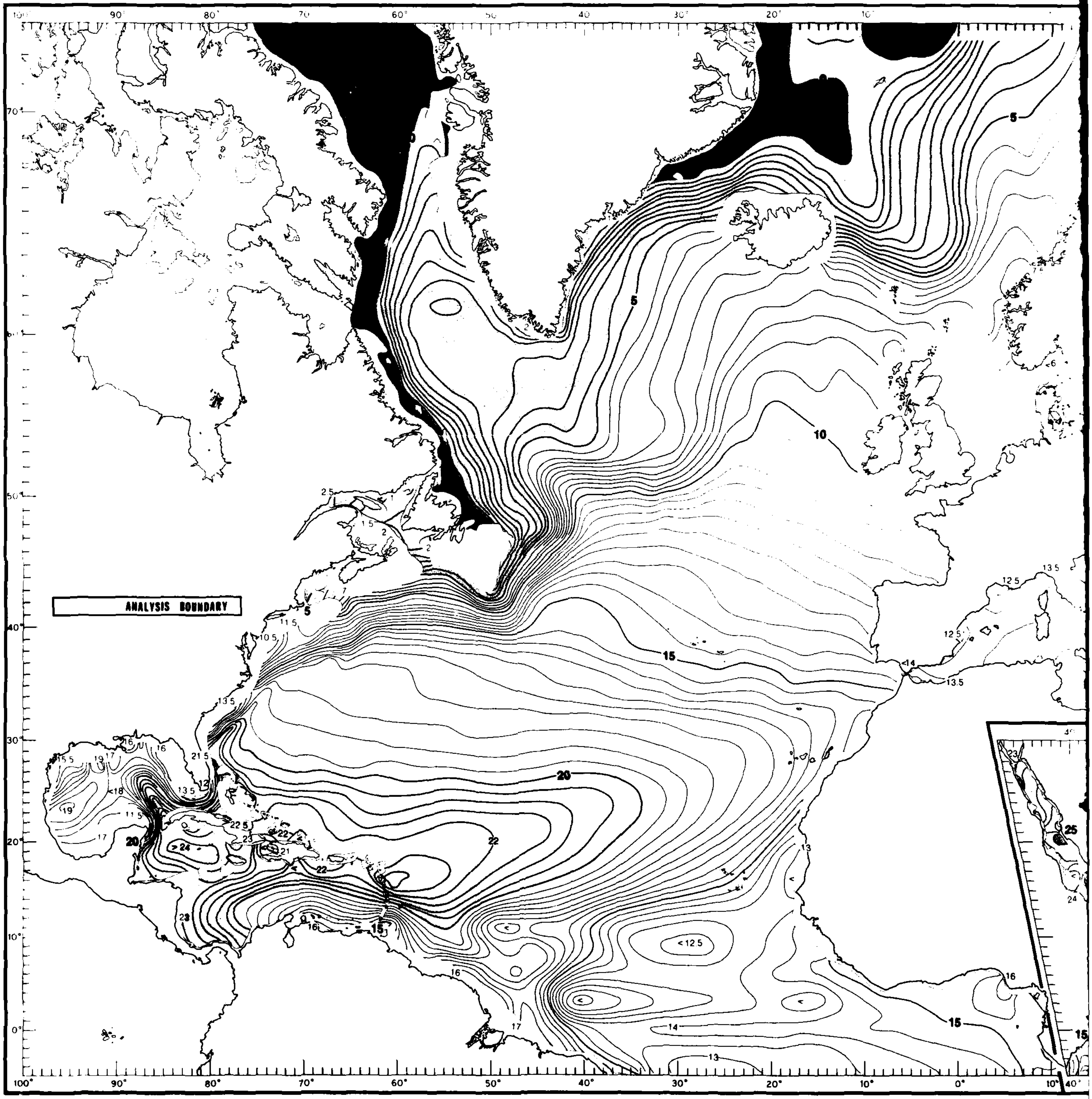
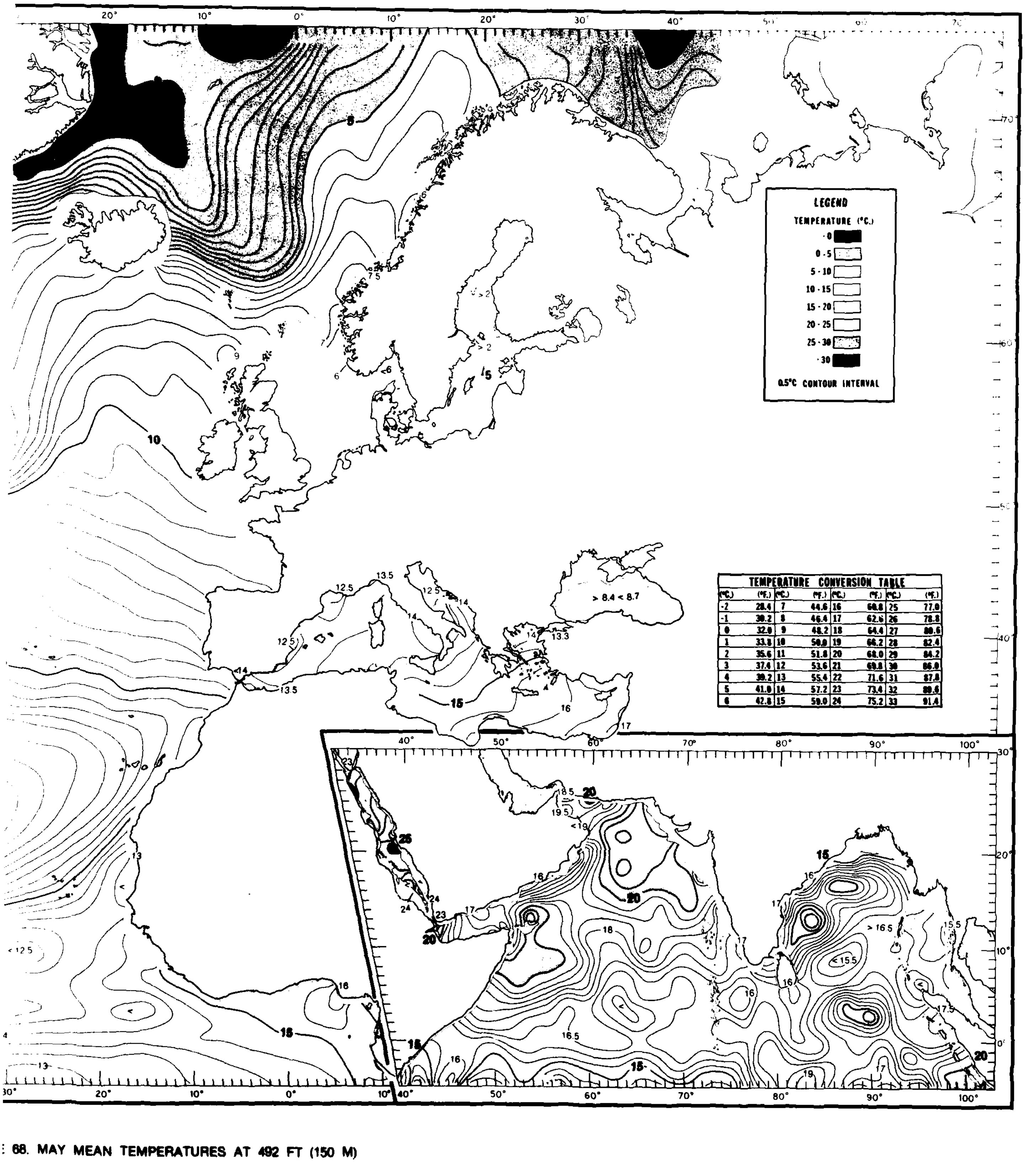


FIGURE 68. MAY MEAN TEMPERATURES AT 492 FT (150 M)



TEMPERATURE CONVERSION TABLE							
(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

68. MAY MEAN TEMPERATURES AT 492 FT (150 M)

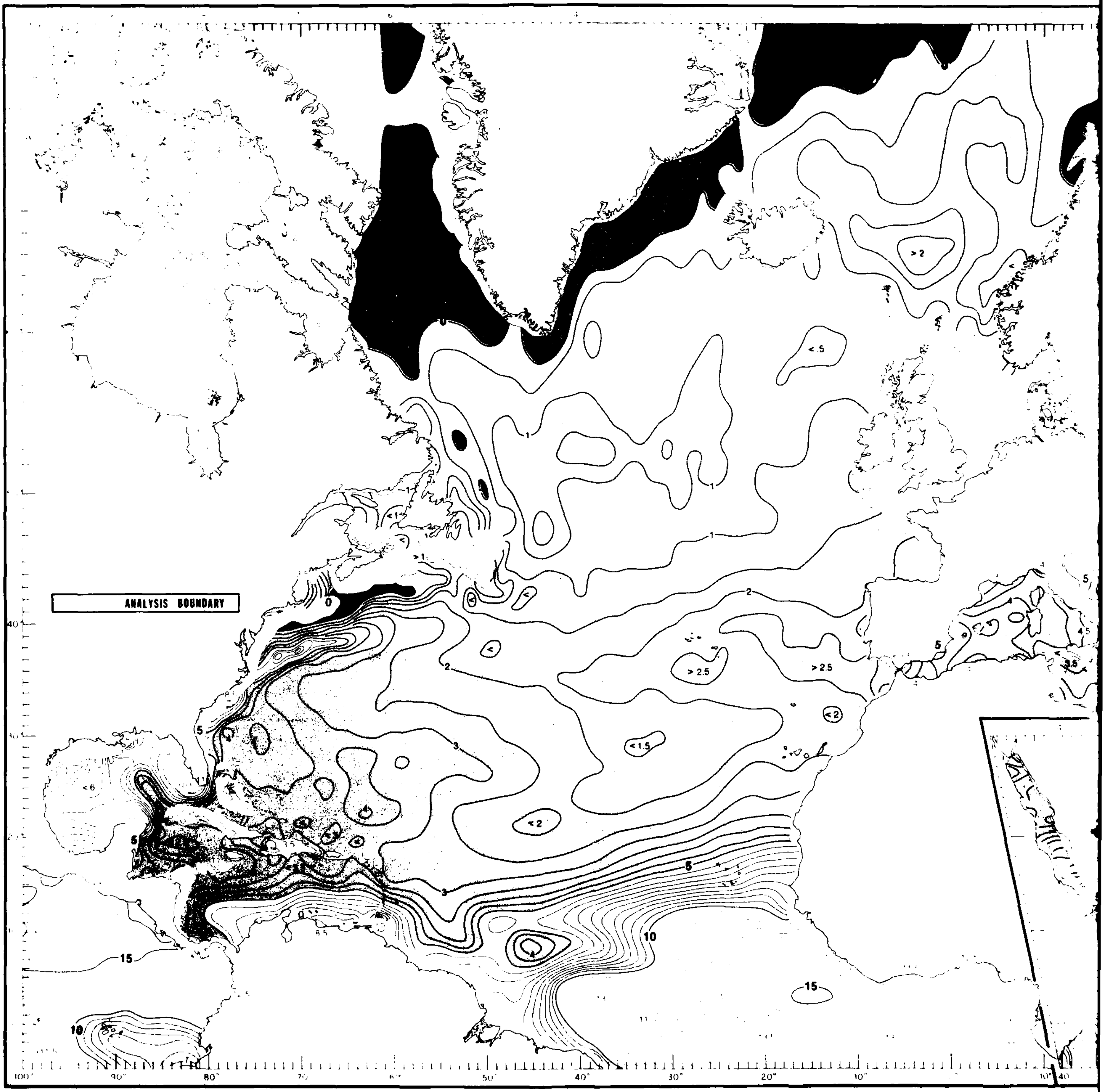
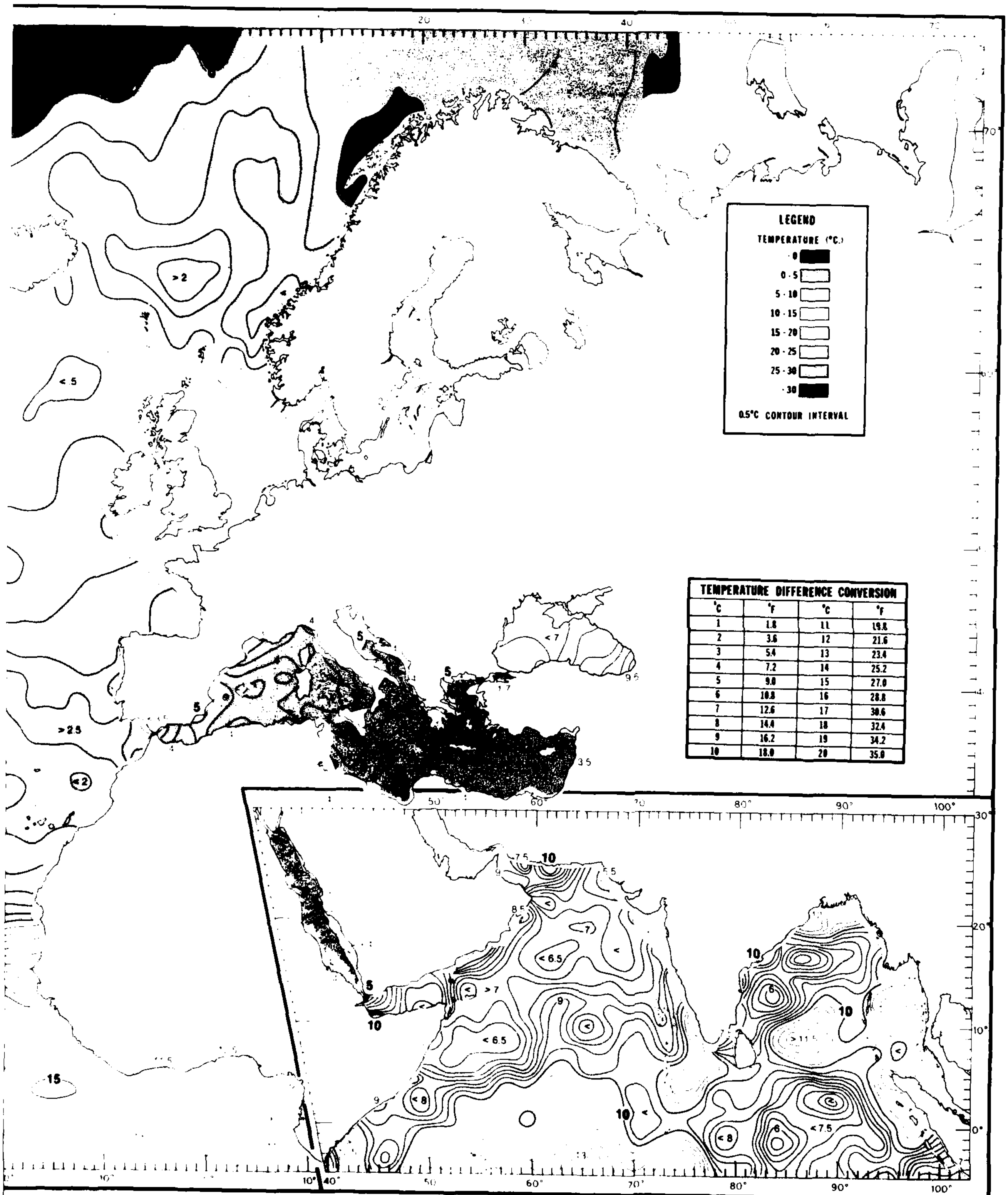


FIGURE 69. MAY TEMPERATURE DIFFERENCE BETWEEN THE SURFACE AND 400 FT



TEMPERATURE DIFFERENCE CONVERSION			
°C	°F	°C	°F
1	1.8	11	19.8
2	3.6	12	21.6
3	5.4	13	23.4
4	7.2	14	25.2
5	9.0	15	27.0
6	10.8	16	28.8
7	12.6	17	30.6
8	14.4	18	32.4
9	16.2	19	34.2
10	18.0	20	35.0

FERENCE BETWEEN THE SURFACE AND 400 FT (T_0-T_{400})

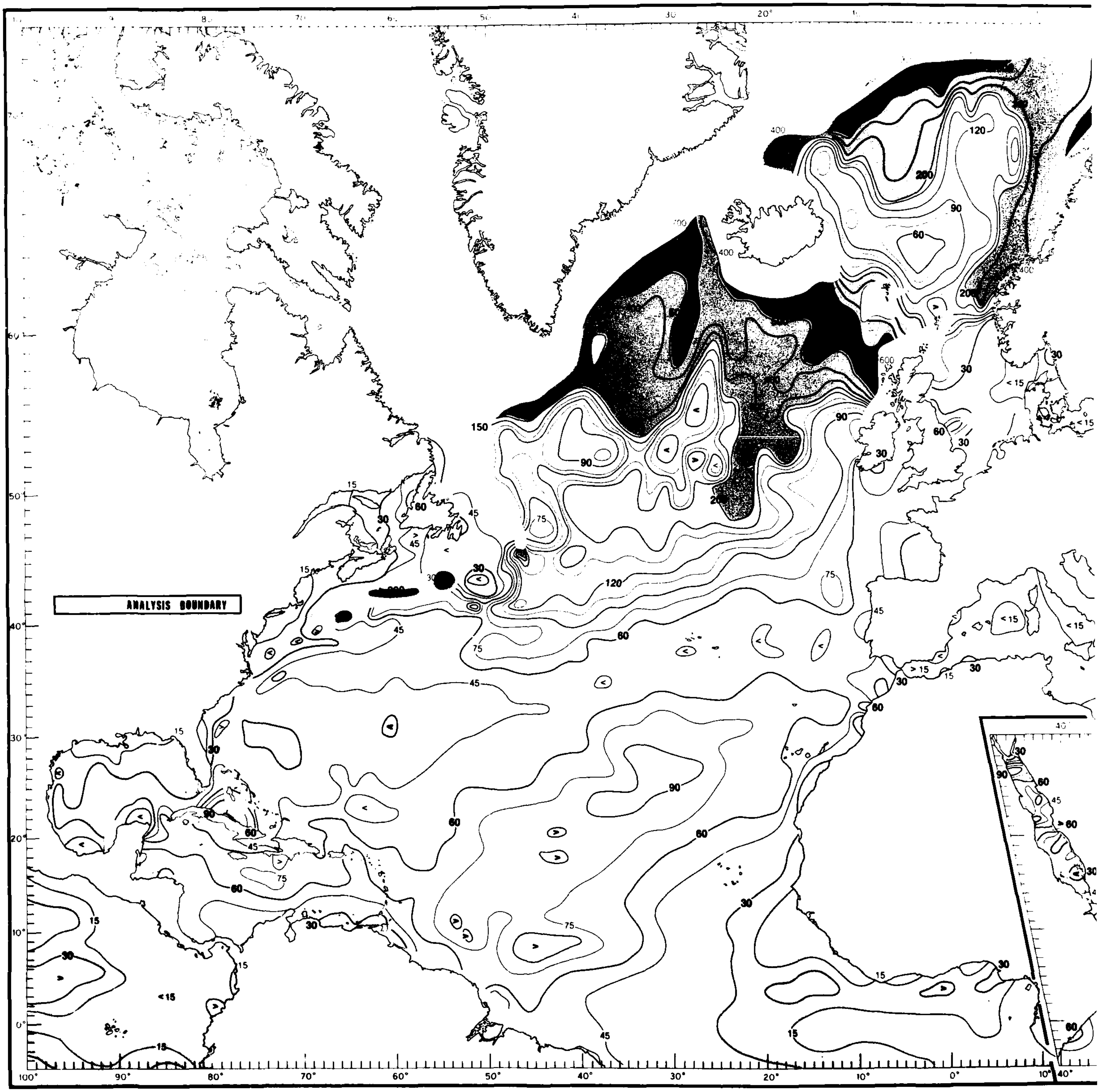
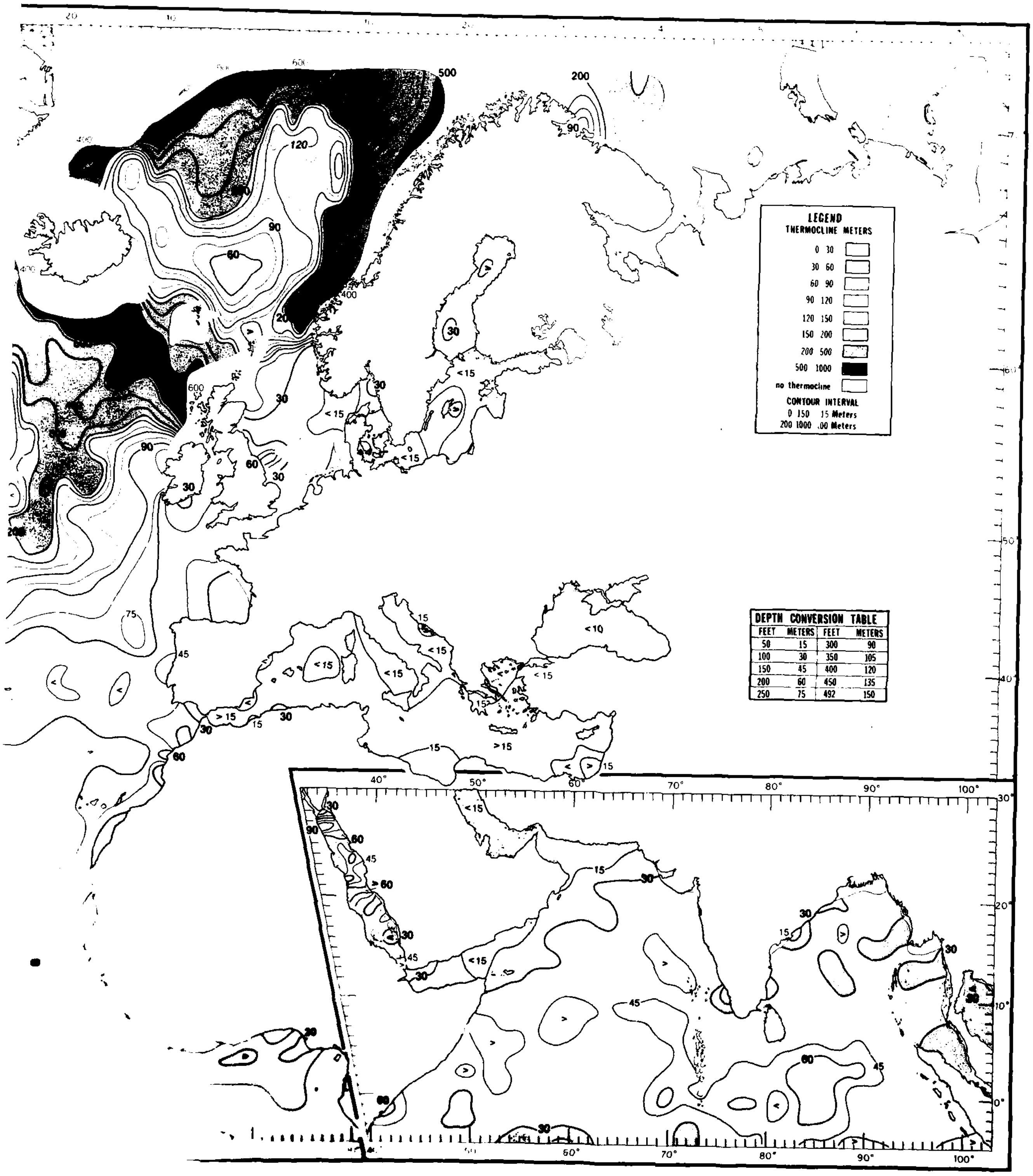


FIGURE 70. MAY MEAN DEPTHS TO THE TOP OF THE THERMOCLINE



DEPTH CONVERSION TABLE			
FEET	METERS	FEET	METERS
50	15	300	90
100	30	350	105
150	45	400	120
200	60	450	135
250	75	492	150

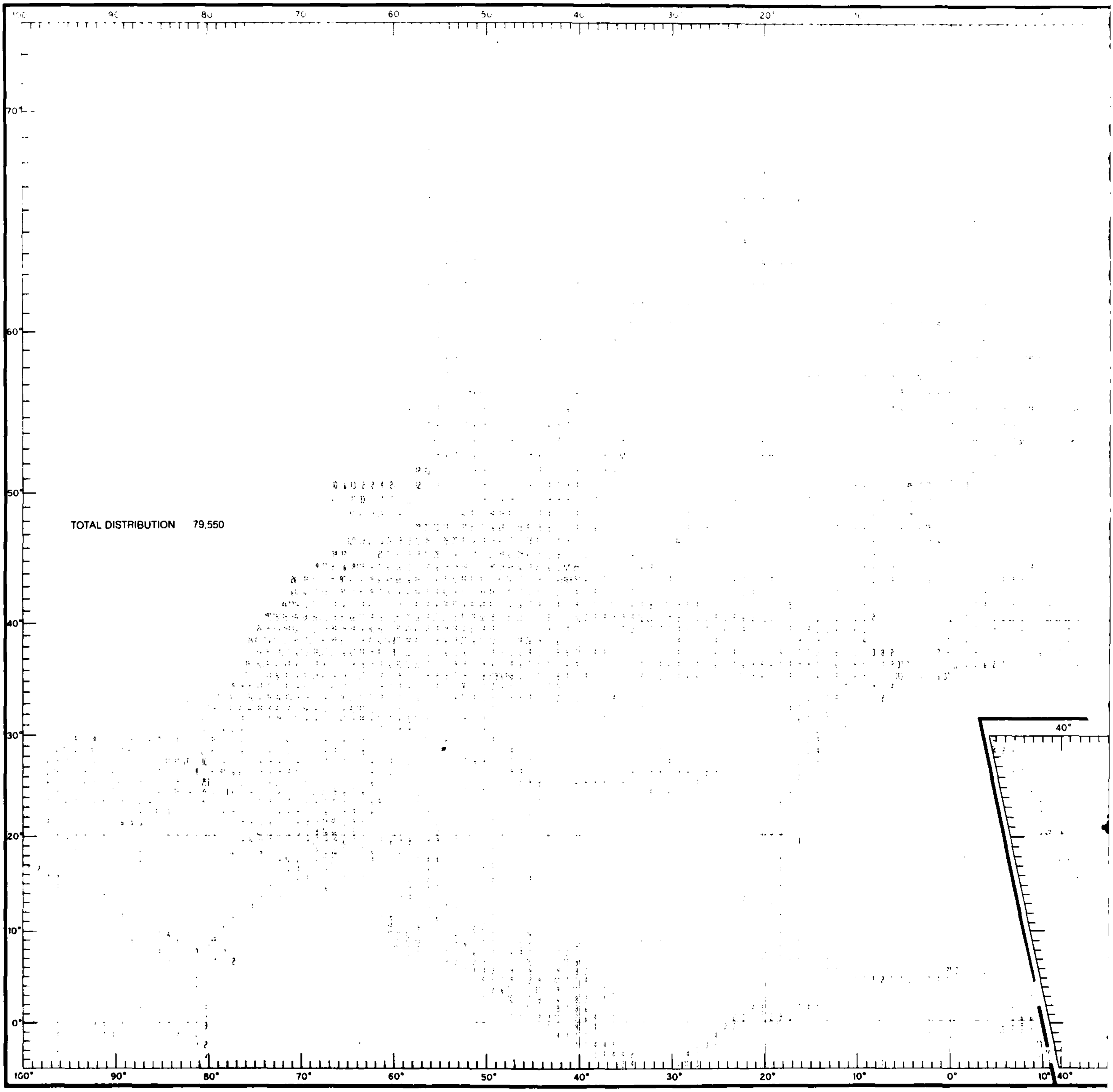
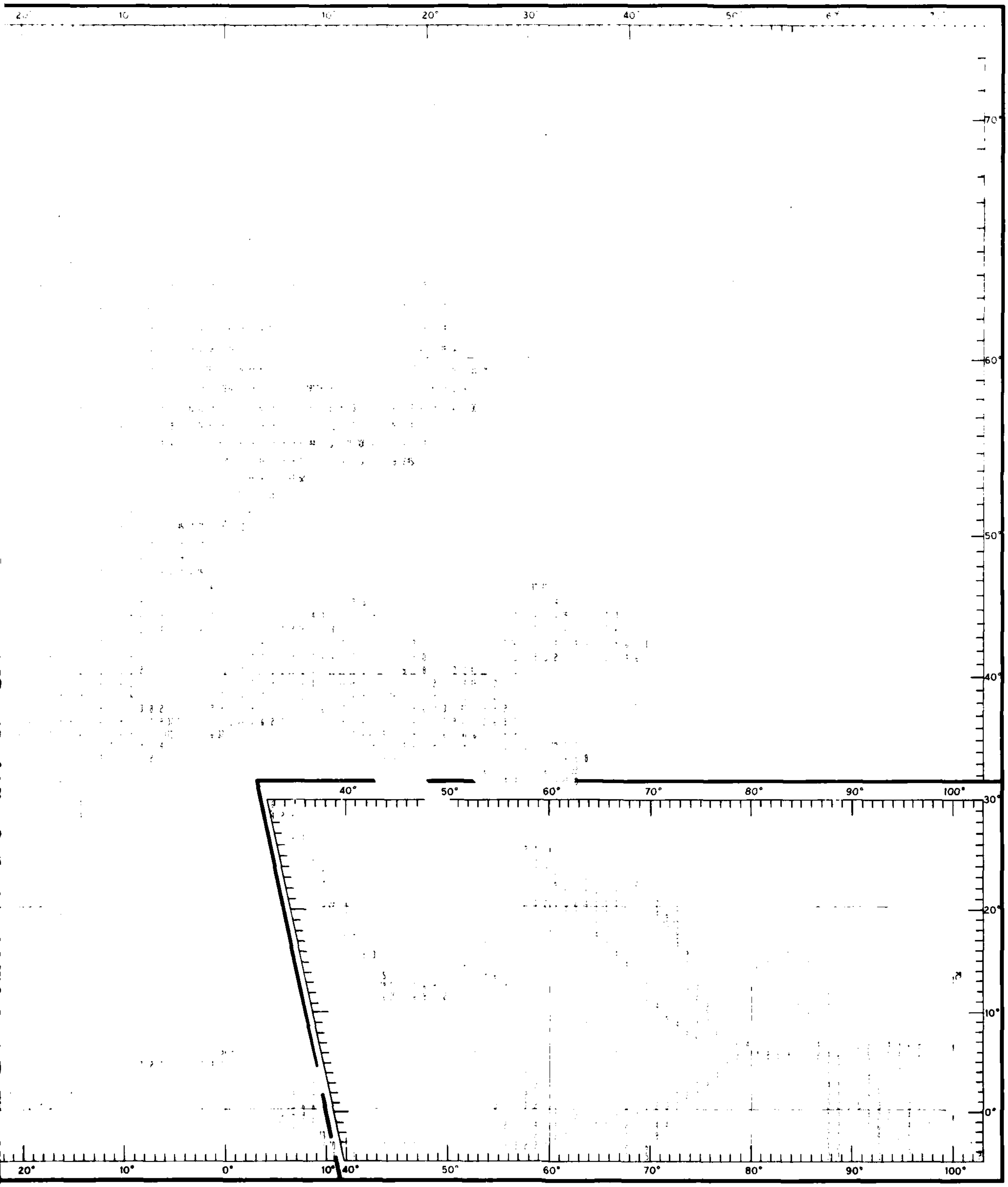


FIGURE 71. JUNE DATA DISTRIBUTION OF TEMPERATURES AT THE SURFACE



STRIBUTION OF TEMPERATURES AT THE SURFACE

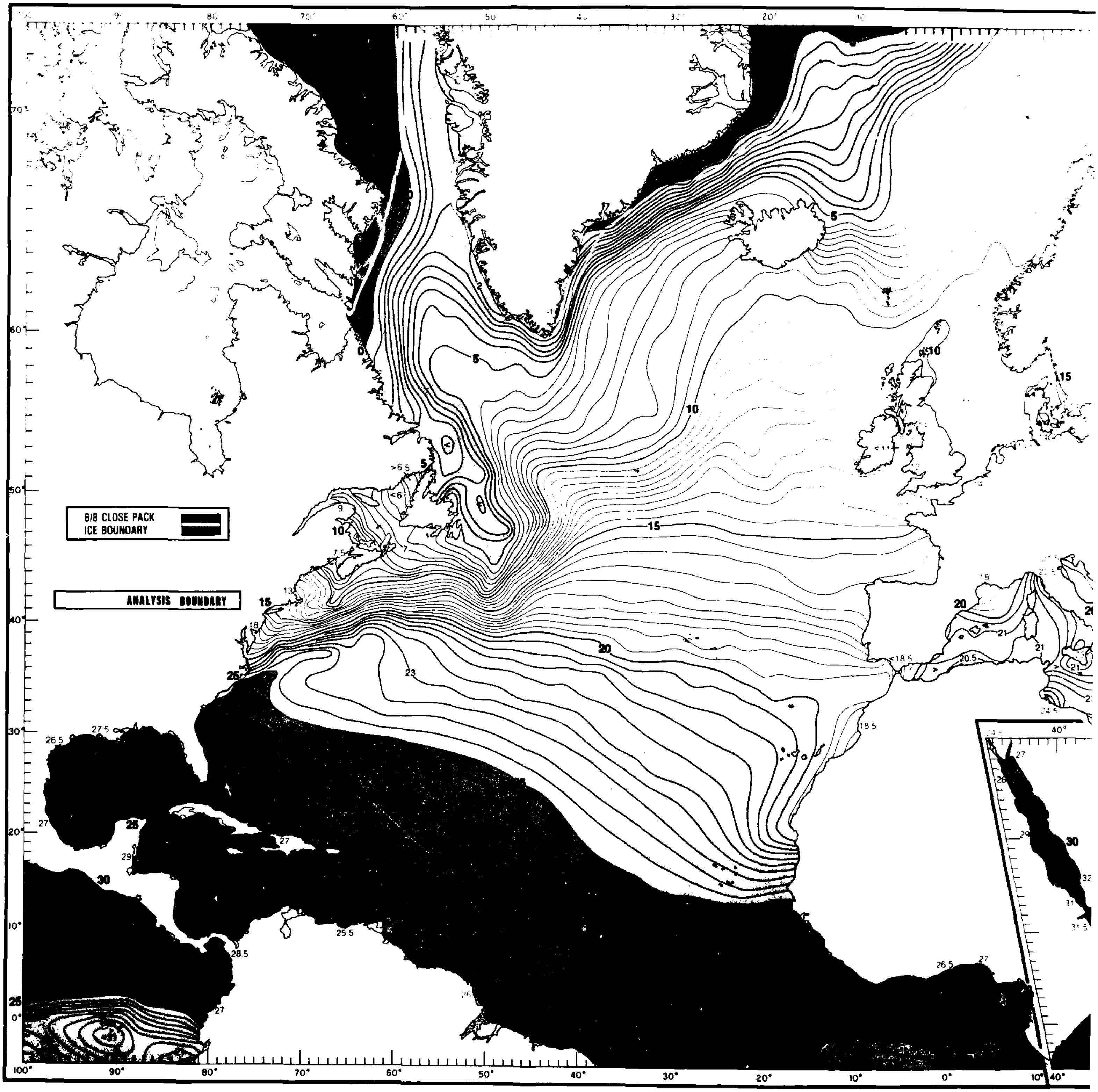
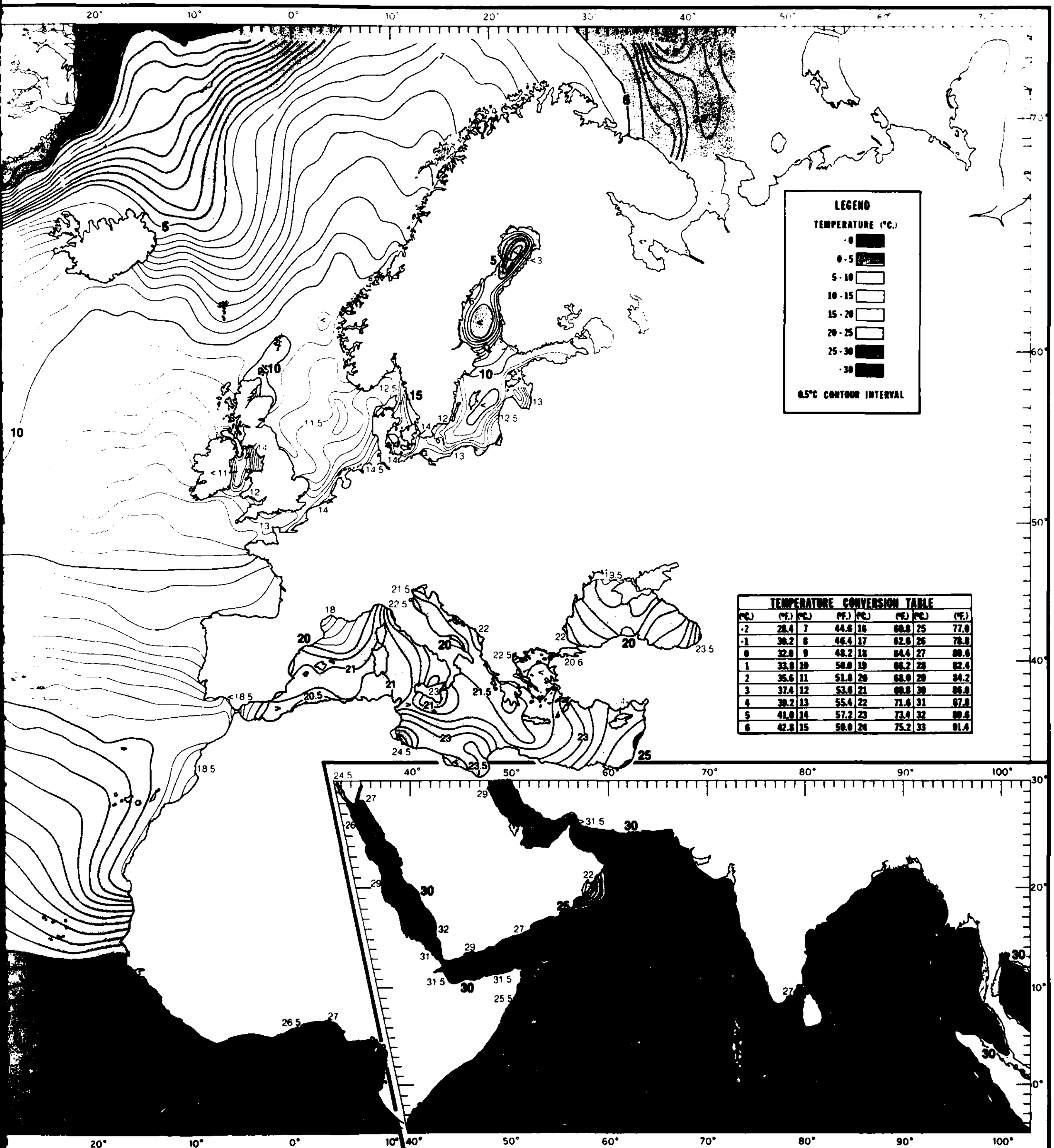


FIGURE 72. JUNE MEAN TEMPERATURES AT THE SURFACE



TEMPERATURE CONVERSION TABLE							
(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

RE 72. JUNE MEAN TEMPERATURES AT THE SURFACE

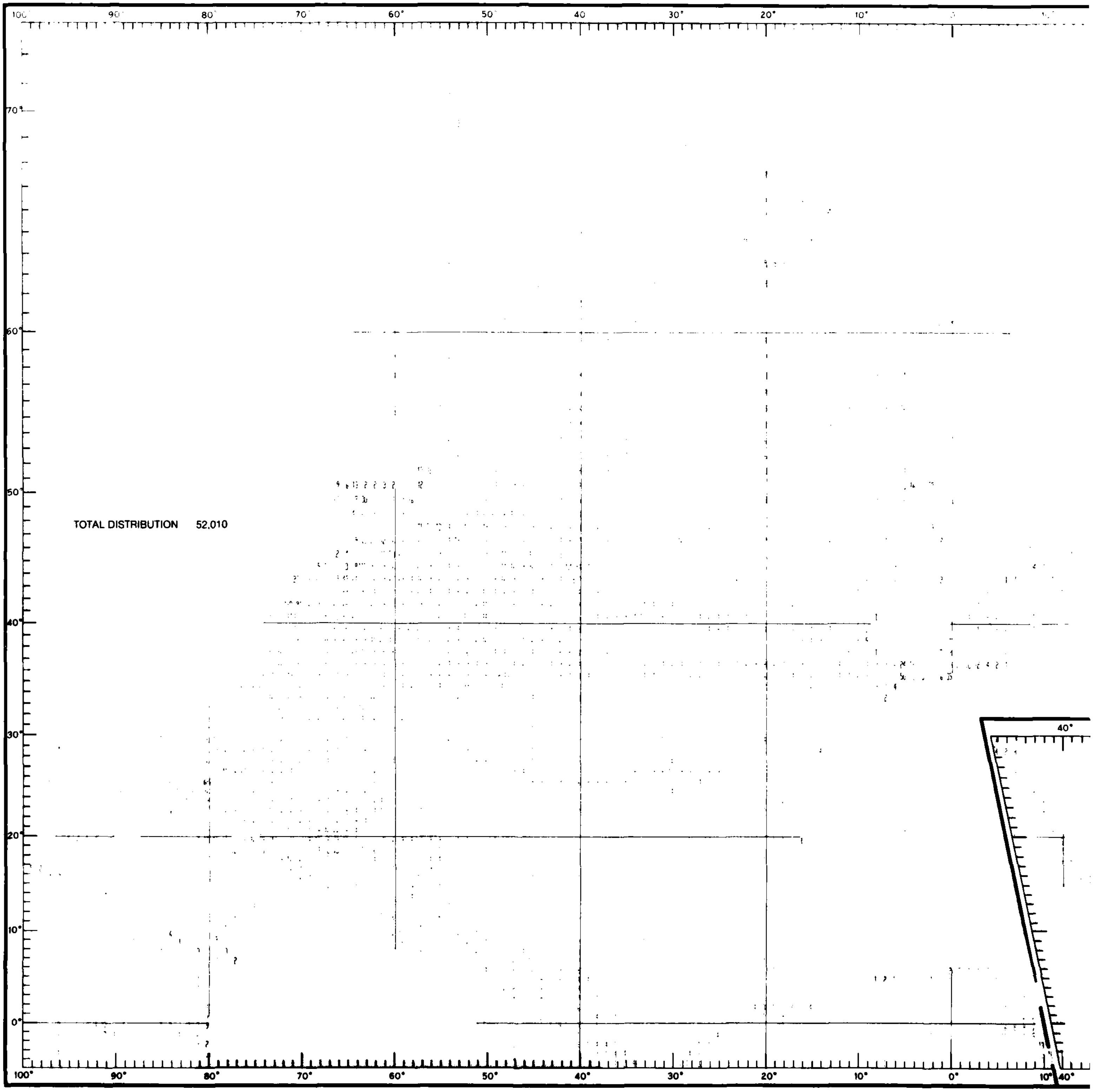
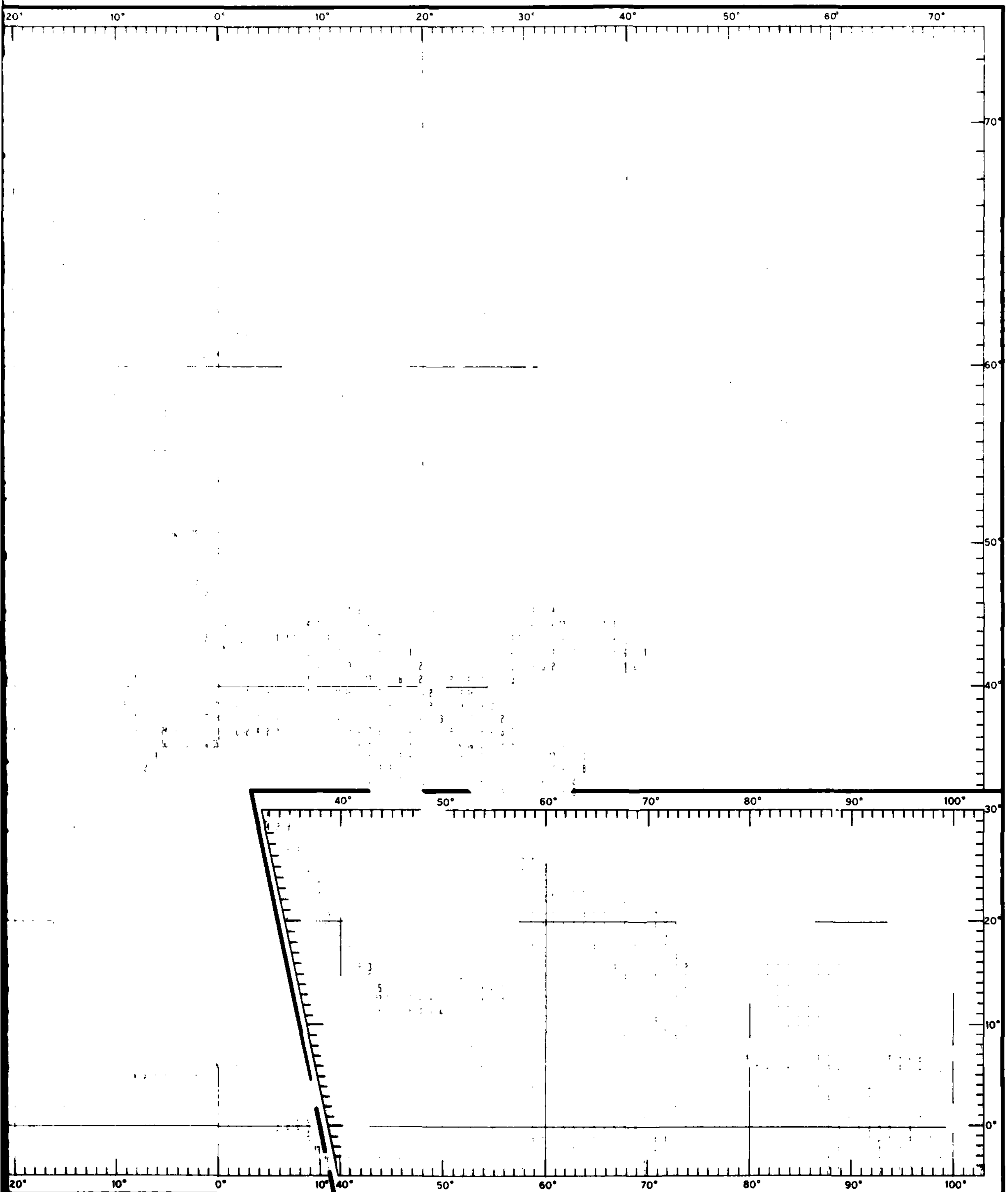


FIGURE 73. JUNE DATA DISTRIBUTION OF TEMPERATURES AT 100 FT (30 M)



TRIBUTION OF TEMPERATURES AT 100 FT (30 M)

1

2

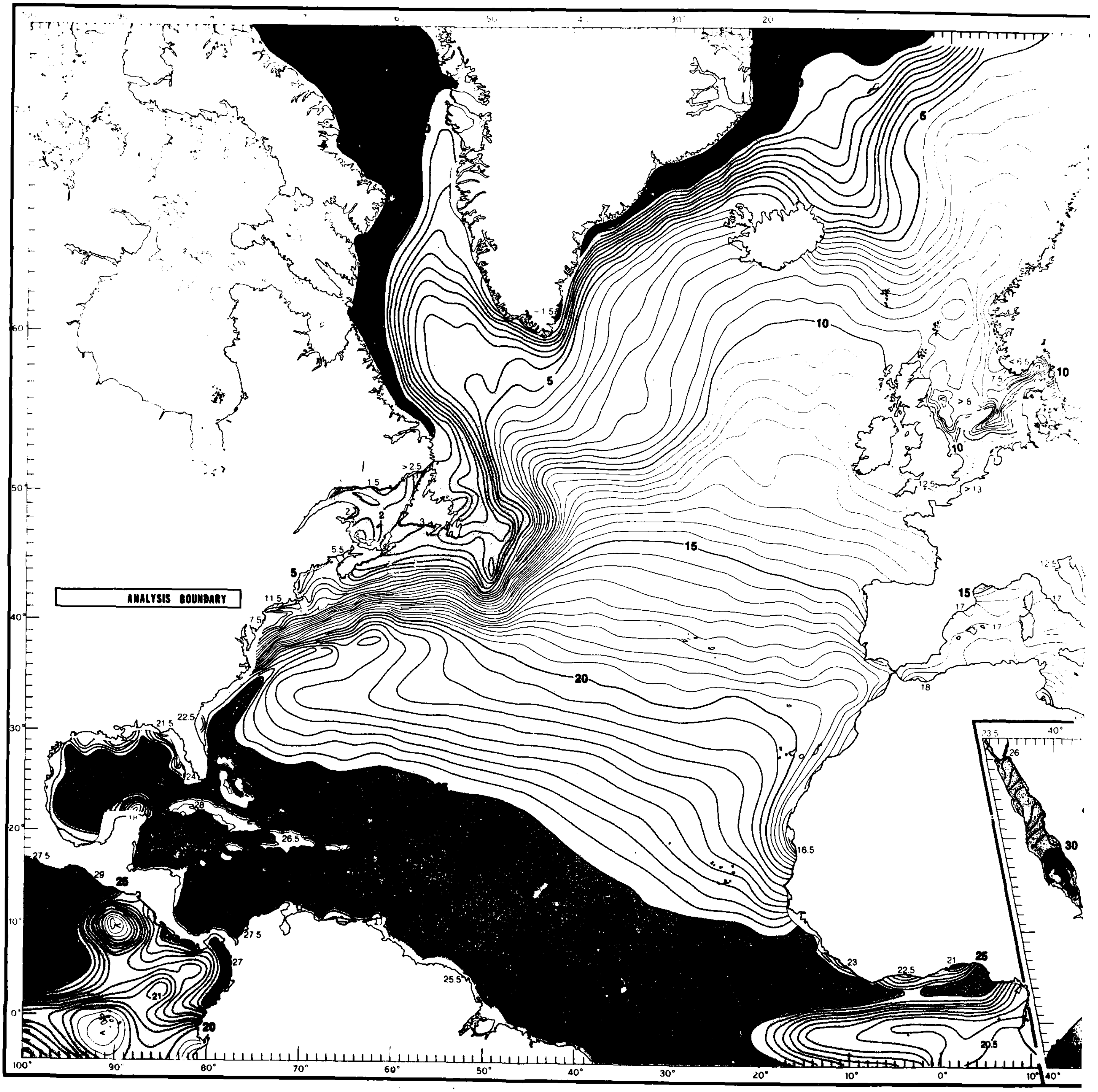
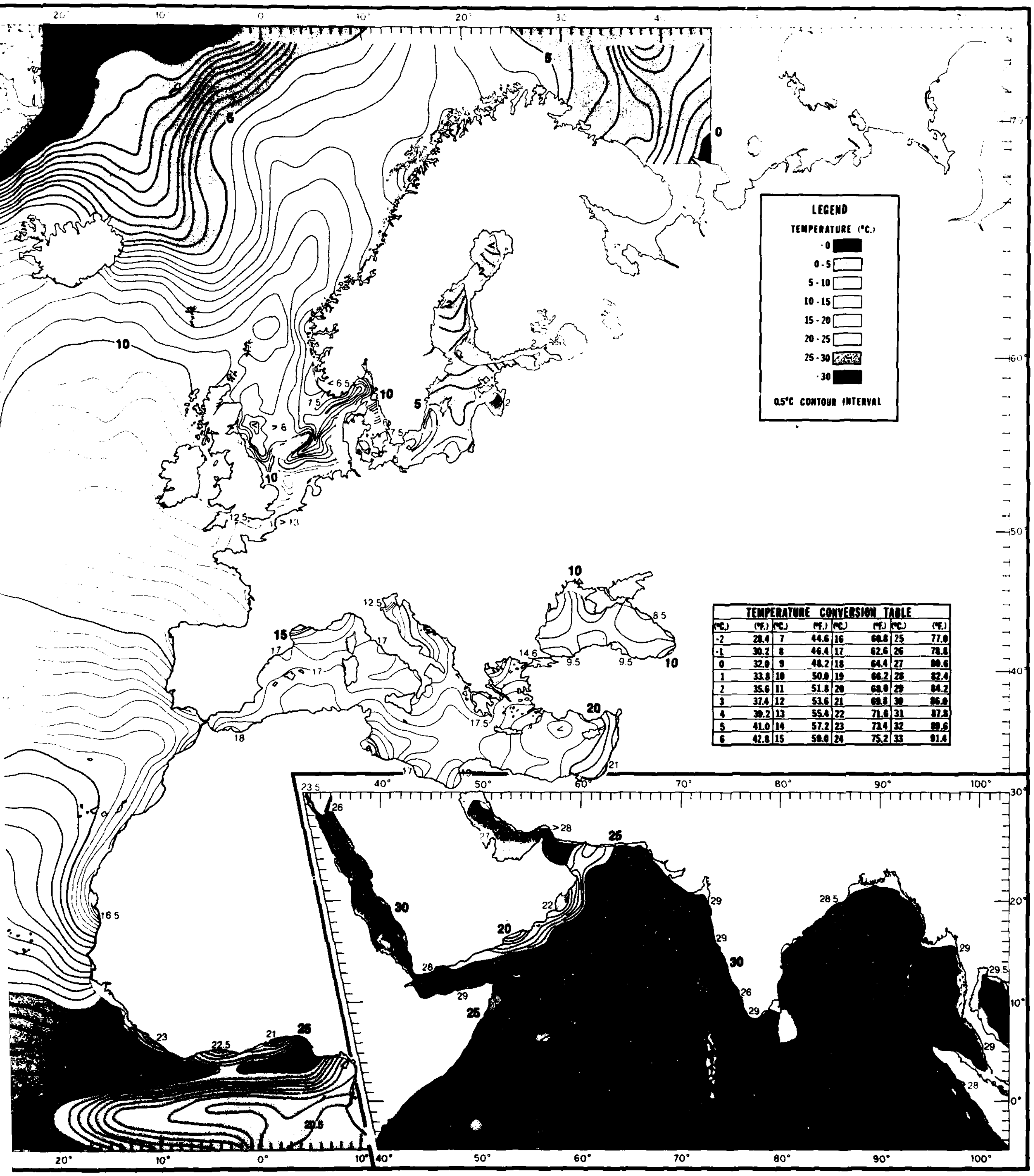


FIGURE 74. JUNE MEAN TEMPERATURES AT 100 FT (30 M)



TEMPERATURE CONVERSION TABLE							
(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

INE MEAN TEMPERATURES AT 100 FT (30 M)

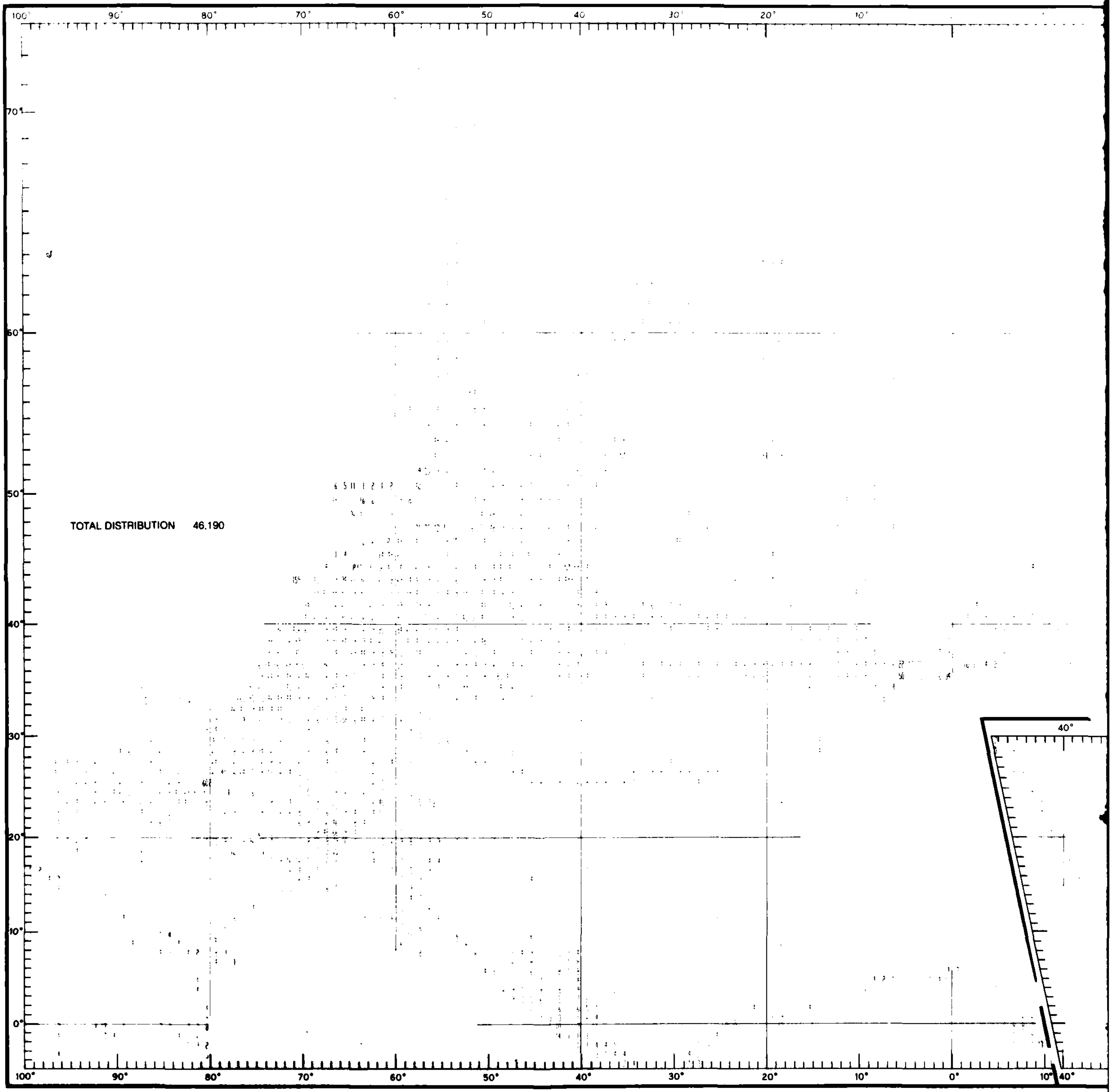
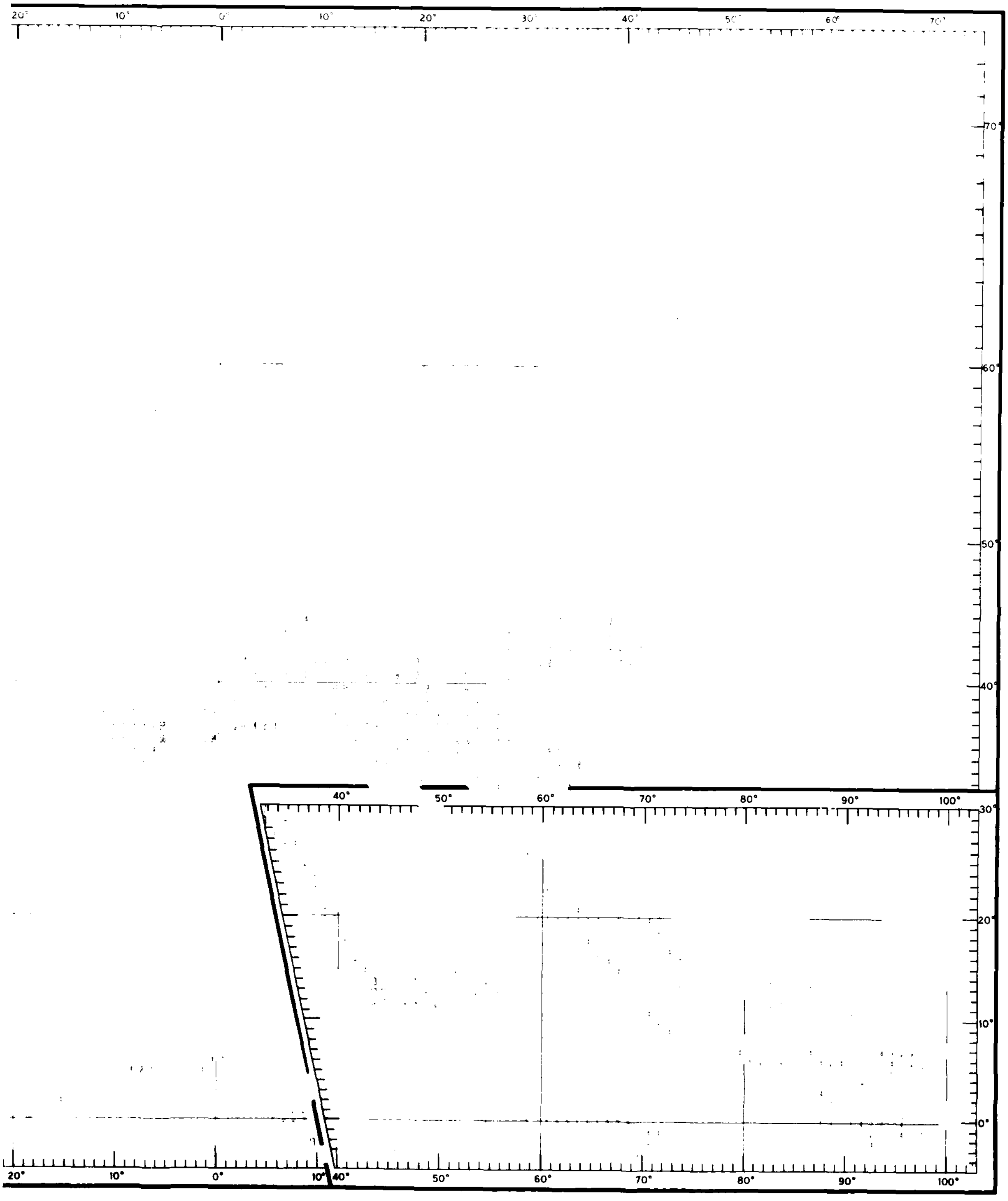


FIGURE 75. JUNE DATA DISTRIBUTION OF TEMPERATURES AT 200 FT (60 M)



RIBUTION OF TEMPERATURES AT 200 FT (60 M)

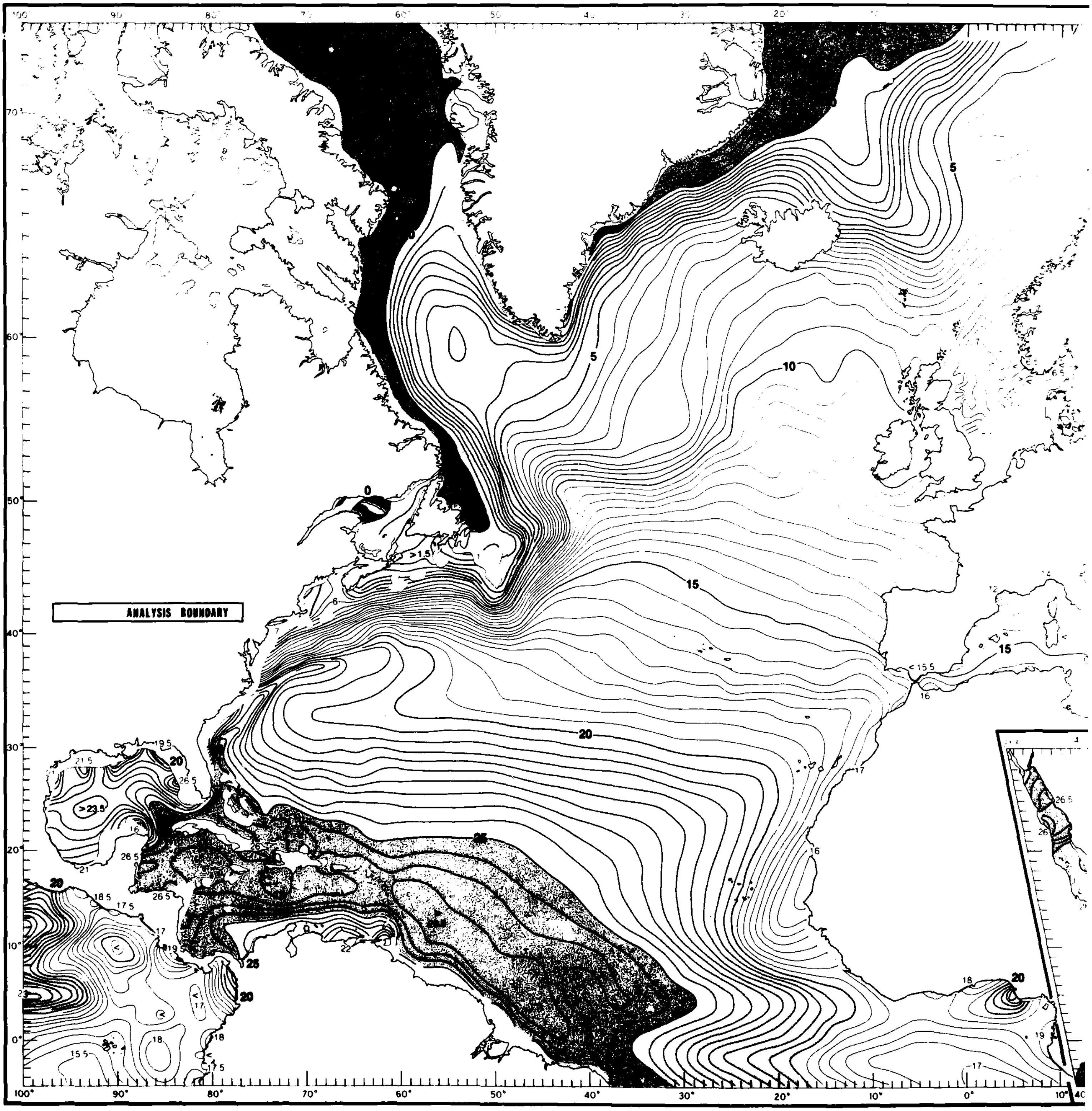
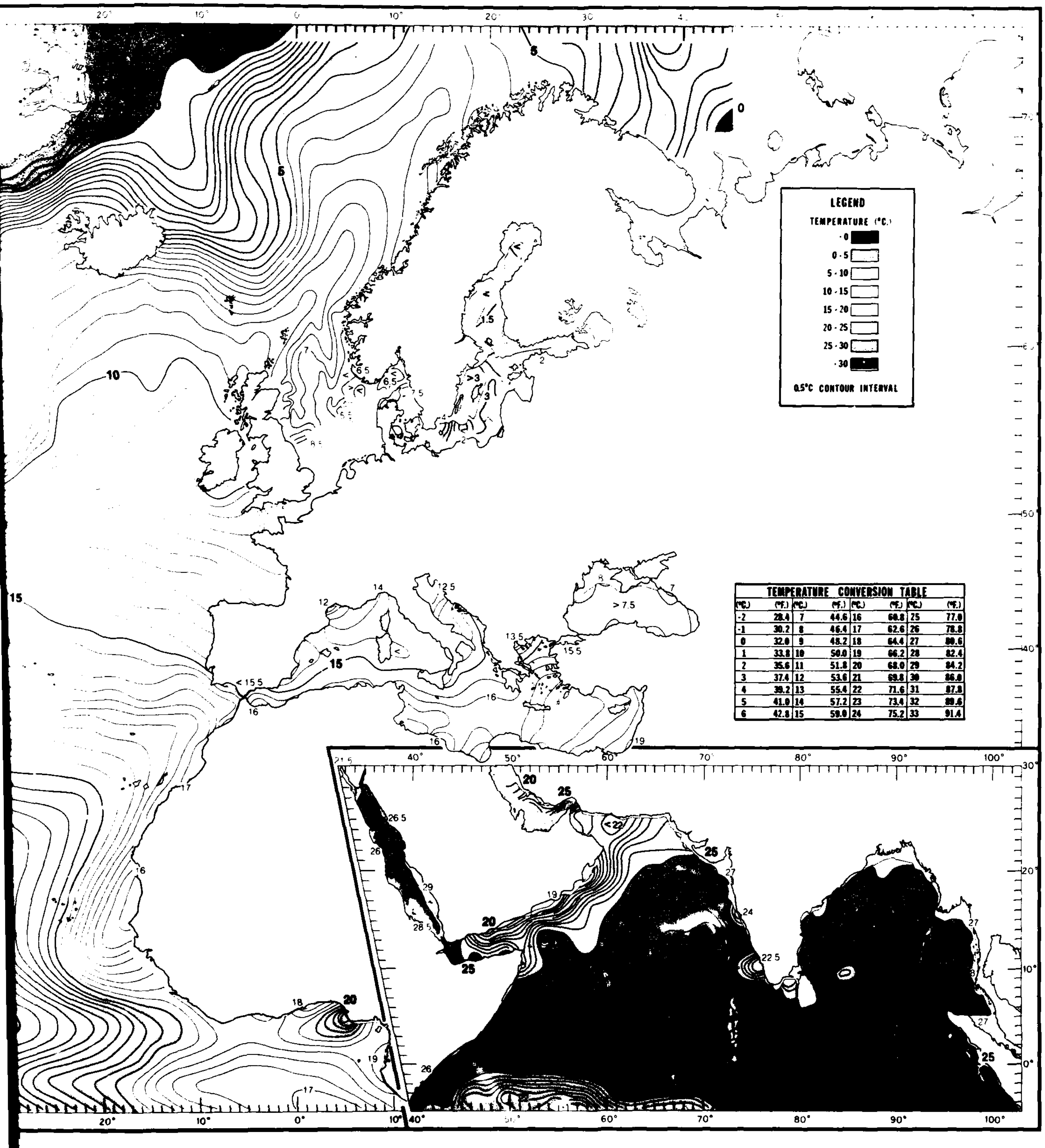


FIGURE 76. JUNE MEAN TEMPERATURES AT 200 FT (60 M)



TEMPERATURE CONVERSION TABLE

(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

76. JUNE MEAN TEMPERATURES AT 200 FT (60 M)

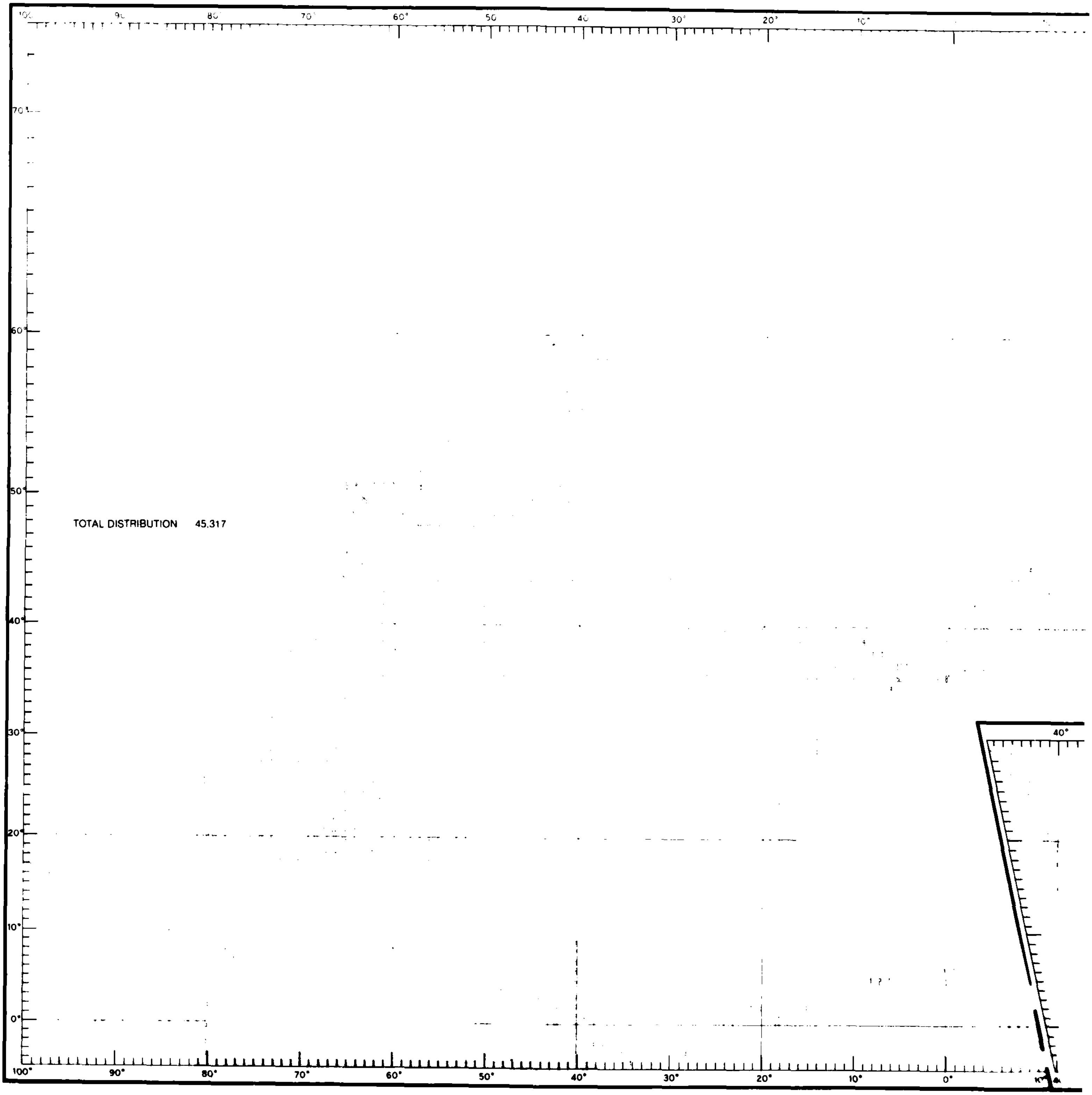
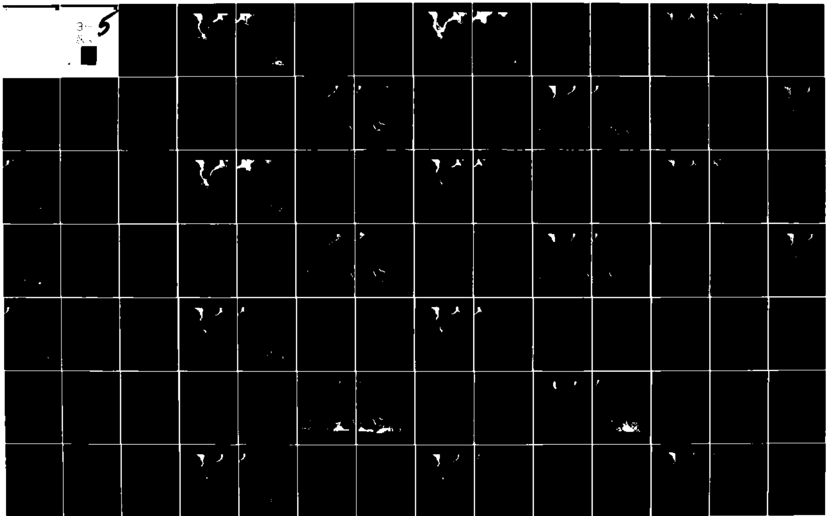
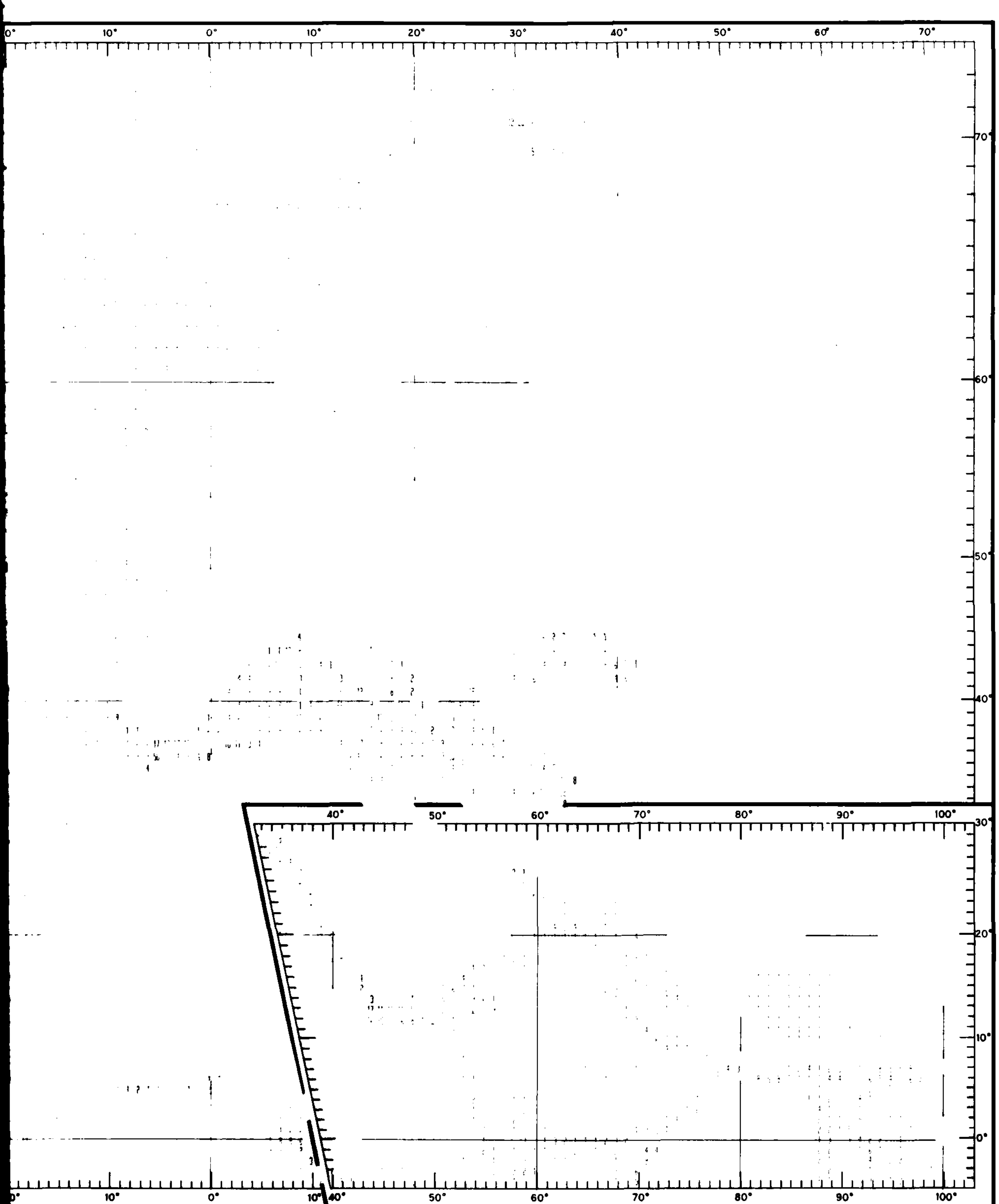


FIGURE 77. JUNE DATA DISTRIBUTION OF TEMPERATURES AT 300 FT

AD-A087 571 NAVAL OCEANOGRAPHIC OFFICE NSTL STATION MS F/G 8/10
ATLAS OF NORTH ATLANTIC-INDIAN OCEAN MONTHLY MEAN TEMPERATURES --ETC(U)
1979 M K ROBINSON, R A BAUER, E H SCHROEDER
UNCLASSIFIED NOO-RP-18 NL

3-5





RIBUTION OF TEMPERATURES AT 300 FT (90 M)

1

2 *

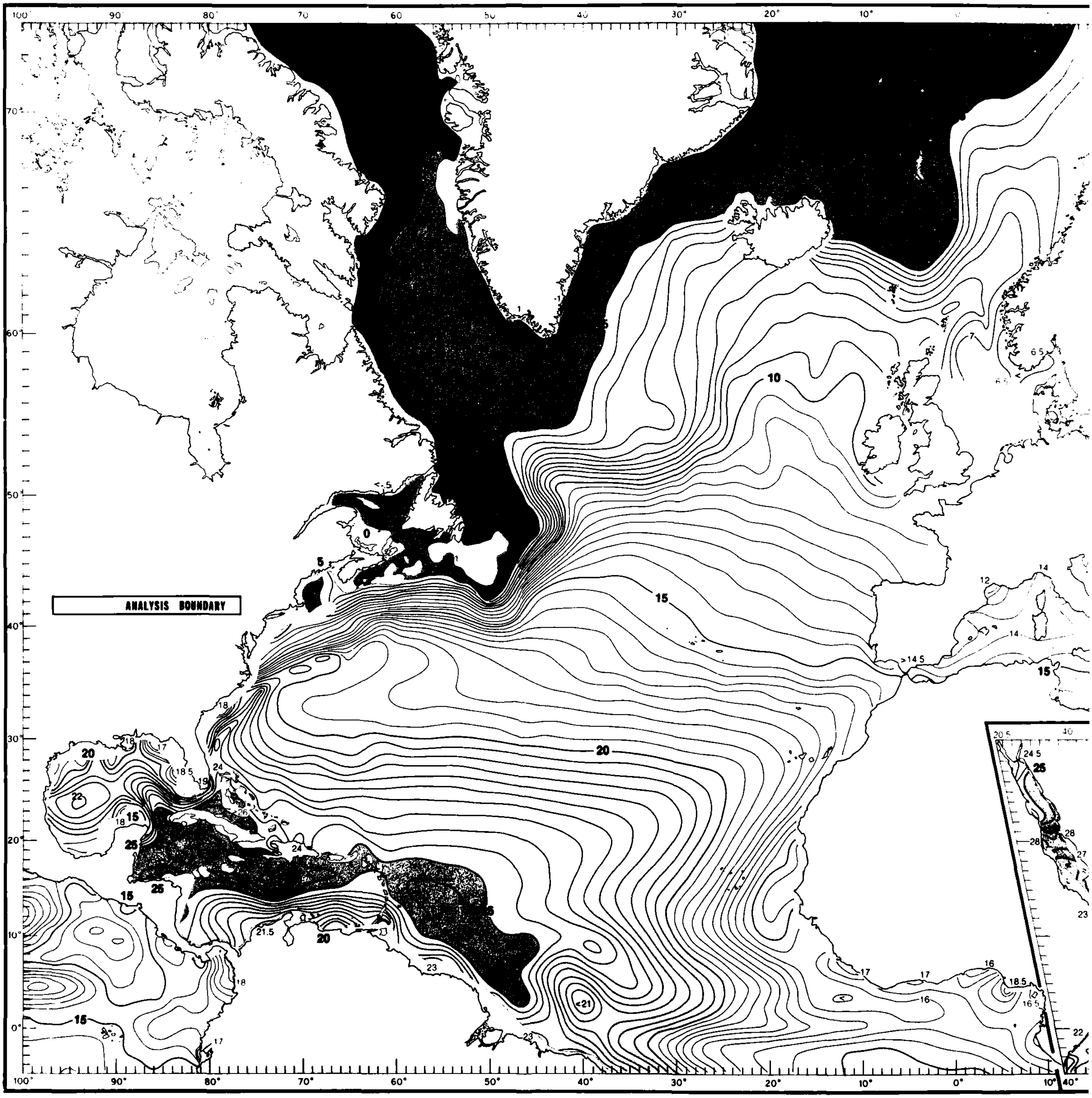
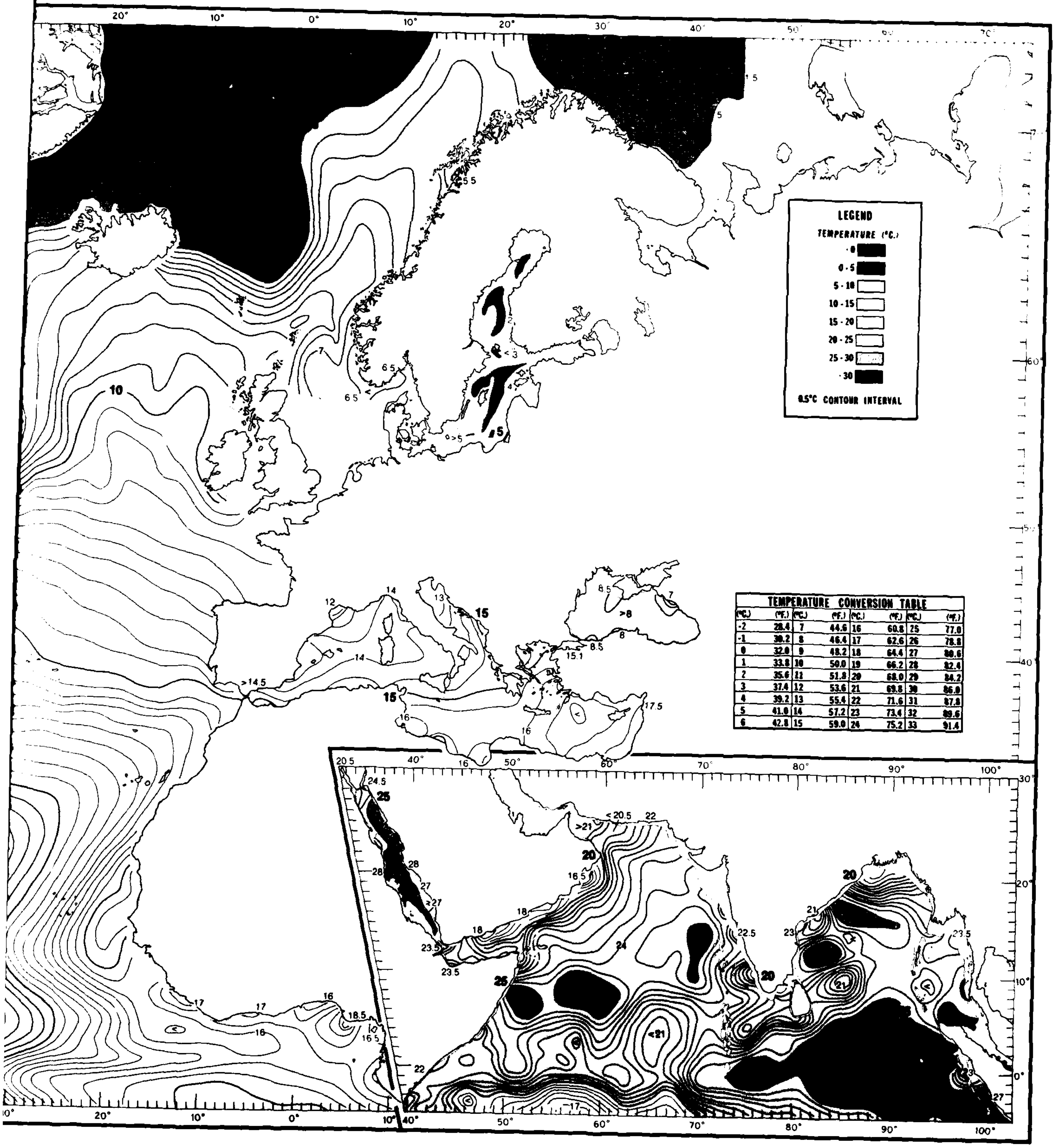


FIGURE 78. JUNE MEAN TEMPERATURES AT 300 FT (90 M)



TEMPERATURE CONVERSION TABLE

(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

RE 78. JUNE MEAN TEMPERATURES AT 300 FT (90 M)

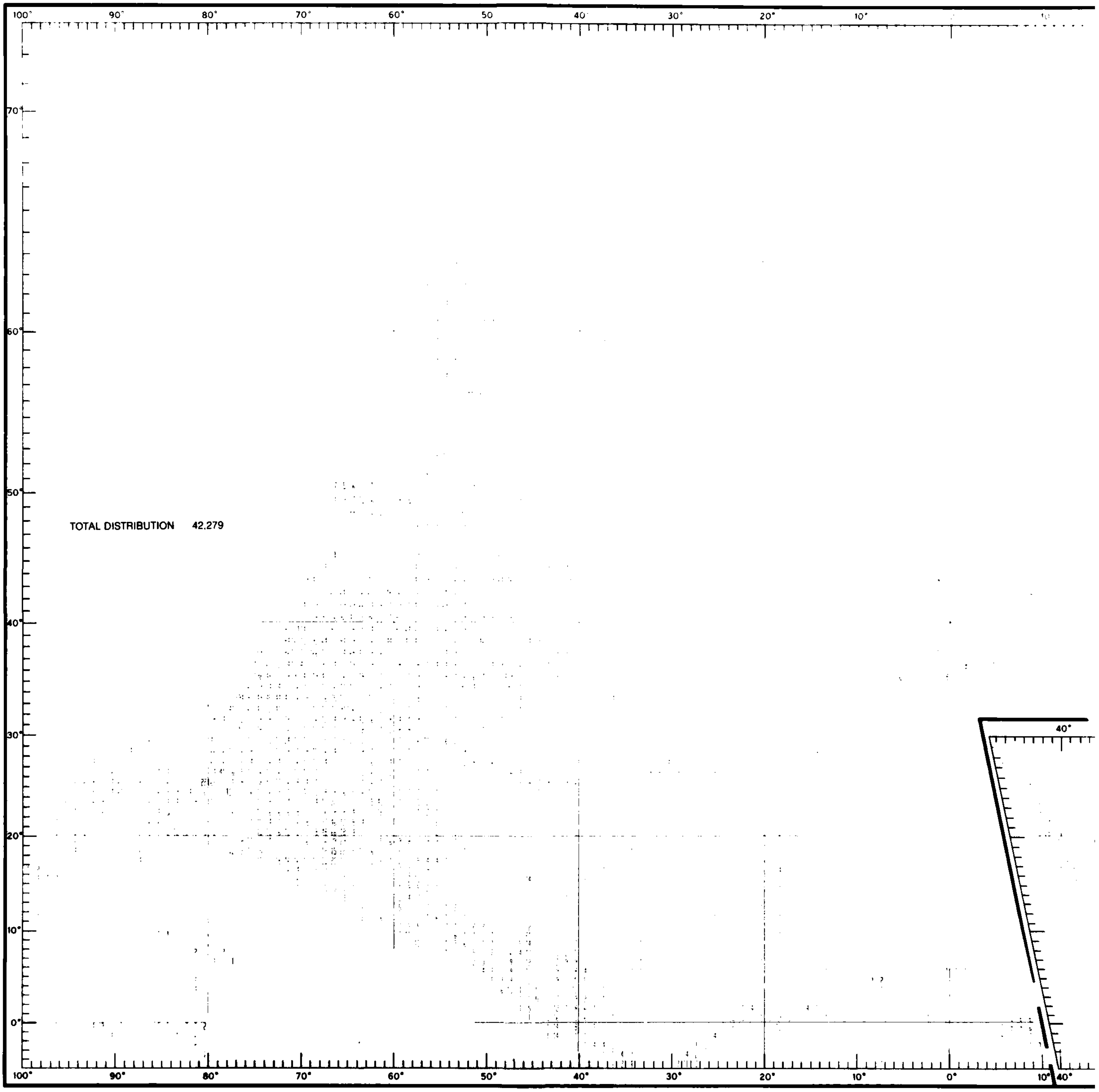
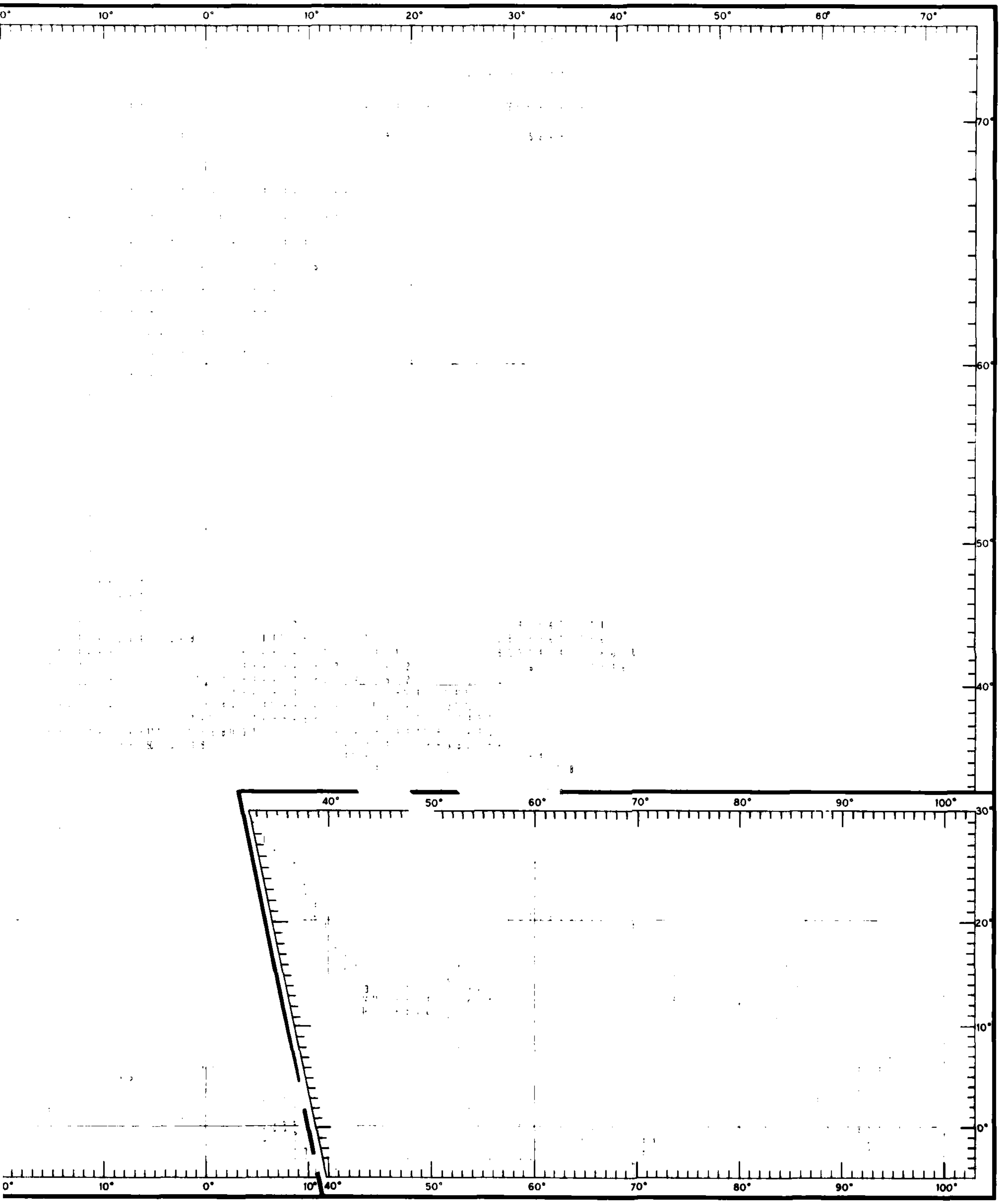


FIGURE 79. JUNE DATA DISTRIBUTION OF TEMPERATURES AT 400 FT (120 M)

1



IBUTION OF TEMPERATURES AT 400 FT (120 M)

1 2

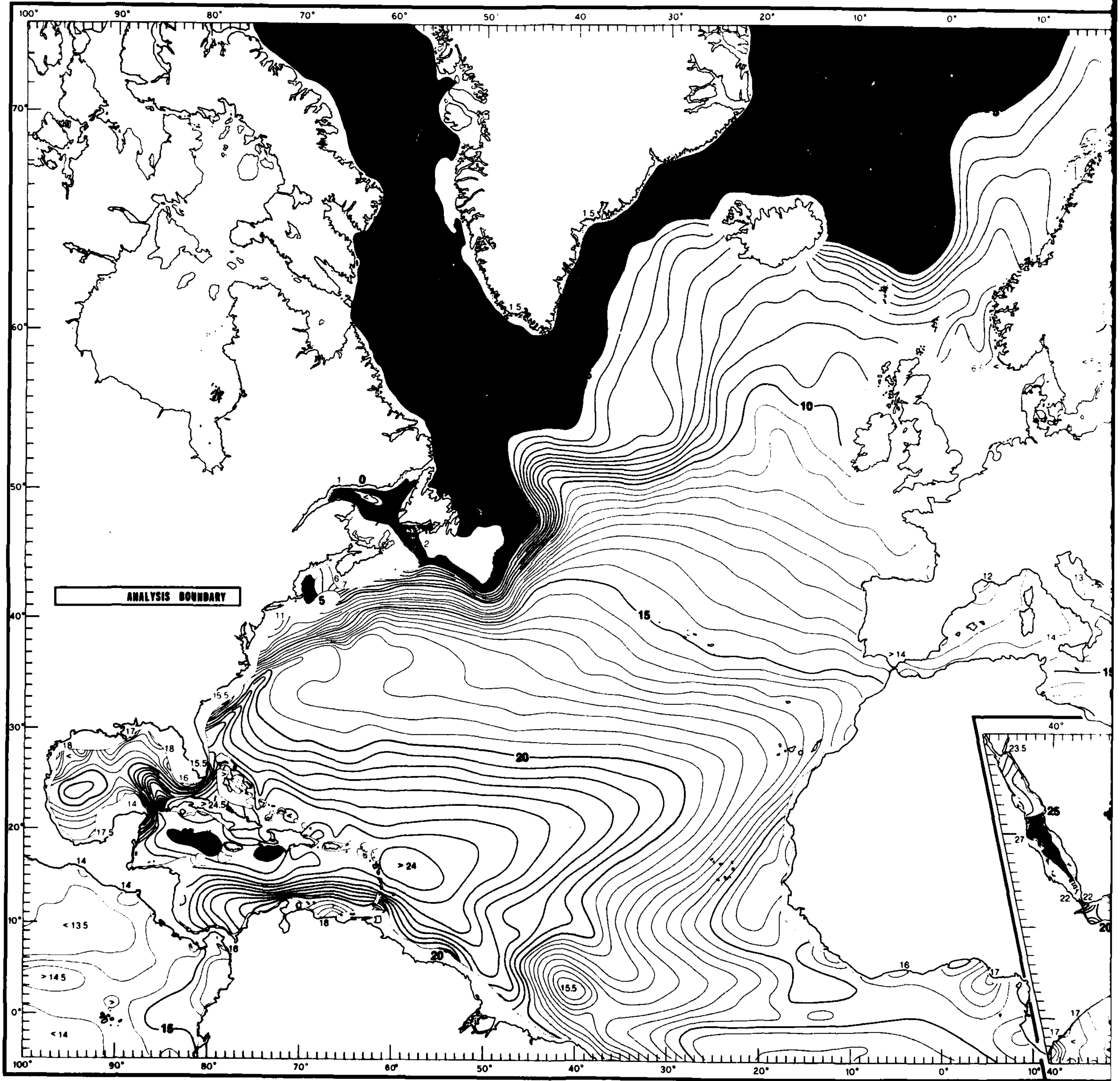
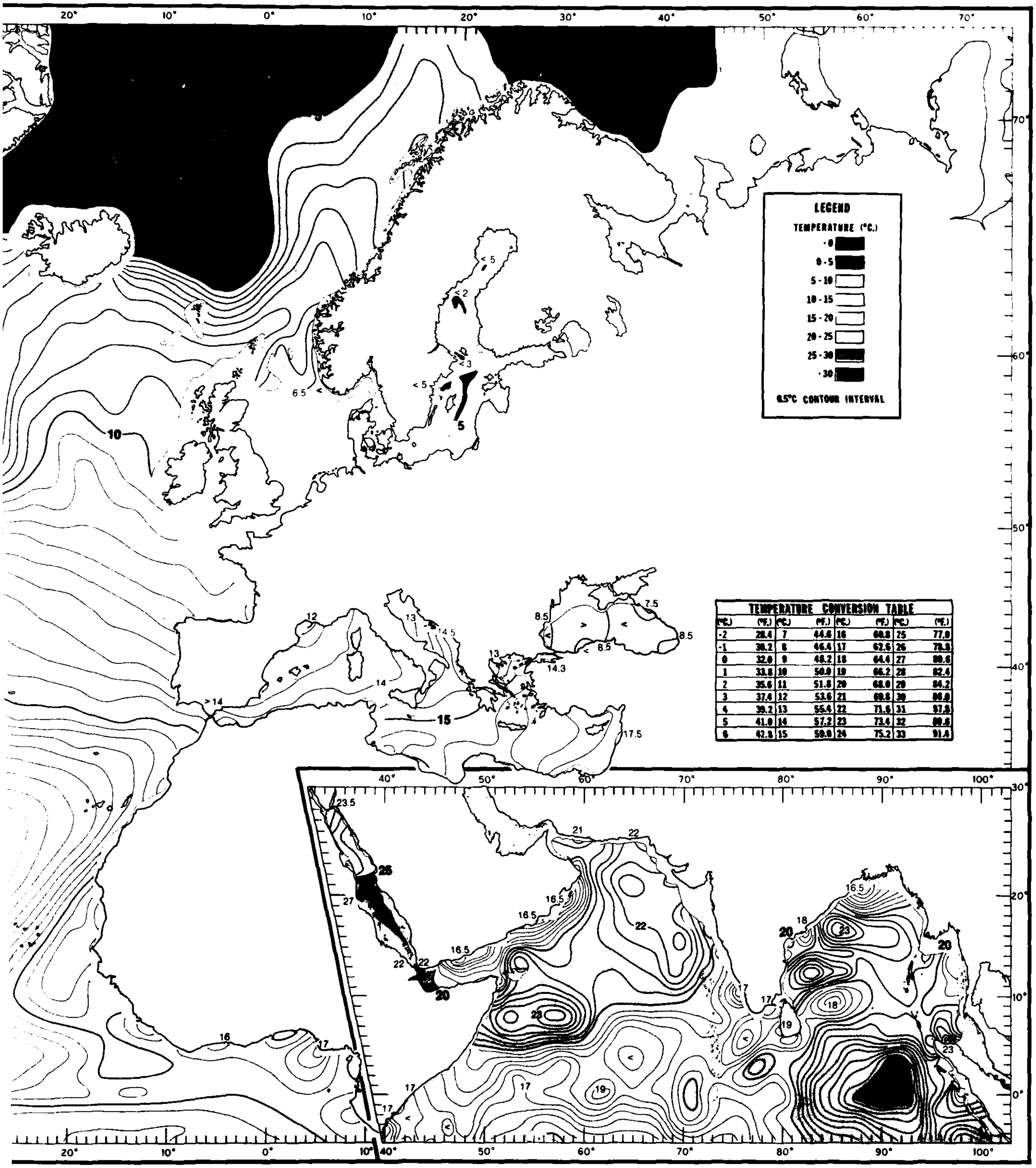


FIGURE 80. JUNE MEAN TEMPERATURES AT 400 FT (120 M)



TEMPERATURE CONVERSION TABLE							
(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

JUNE MEAN TEMPERATURES AT 400 FT (120 M)

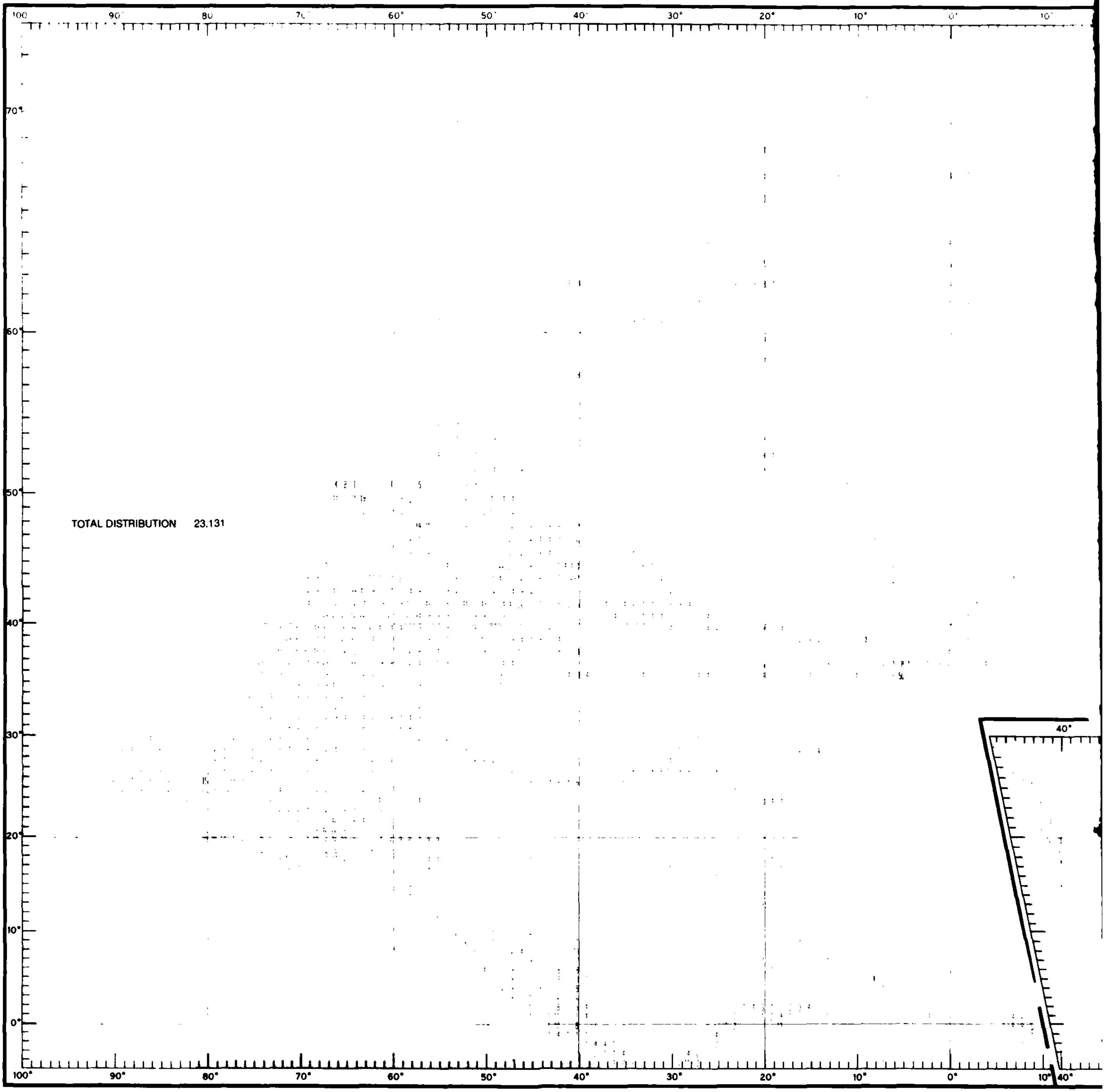
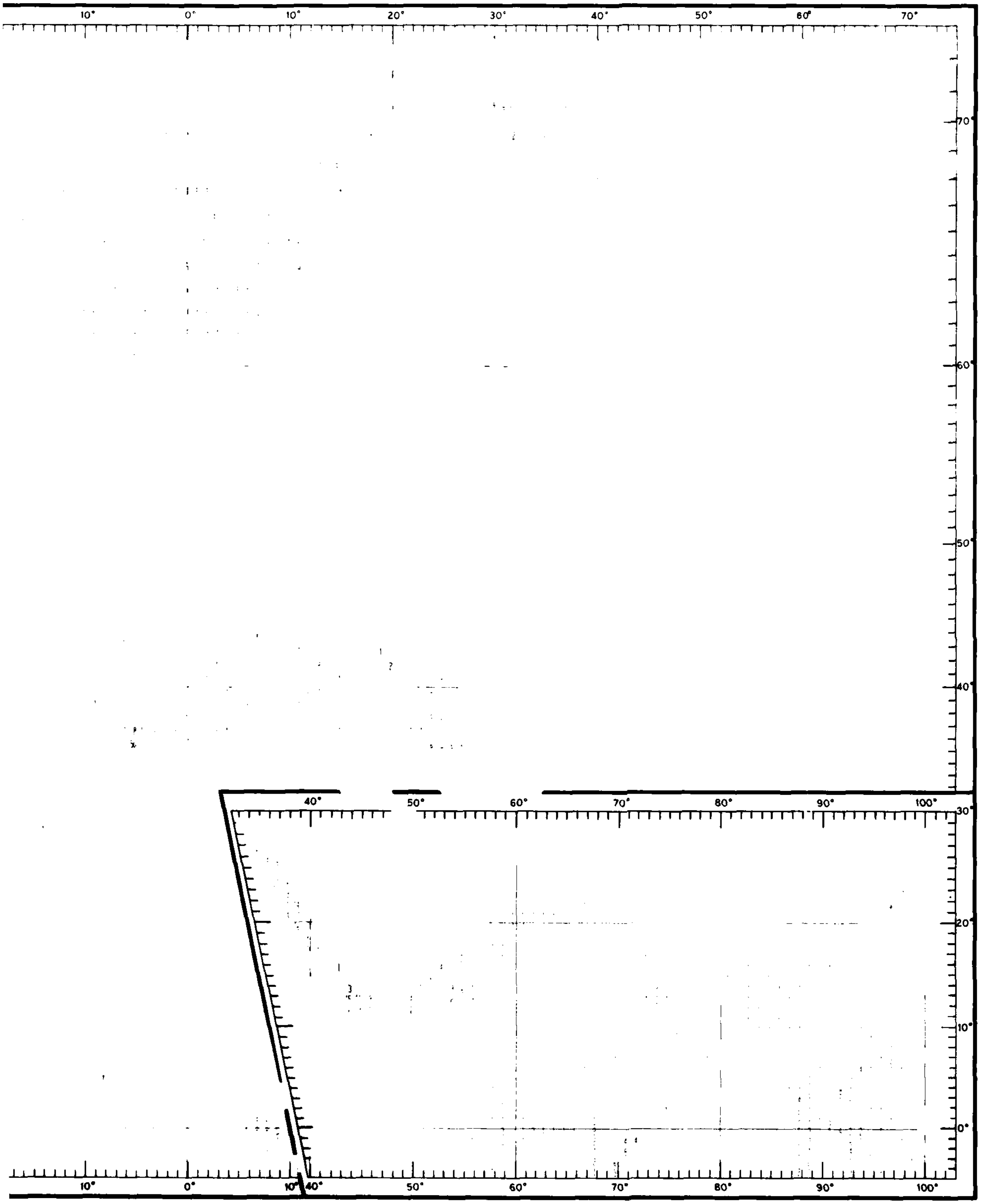


FIGURE 81. JUNE DATA DISTRIBUTION OF TEMPERATURES AT 492 FT (150 M)

1



TION OF TEMPERATURES AT 492 FT (150 M)

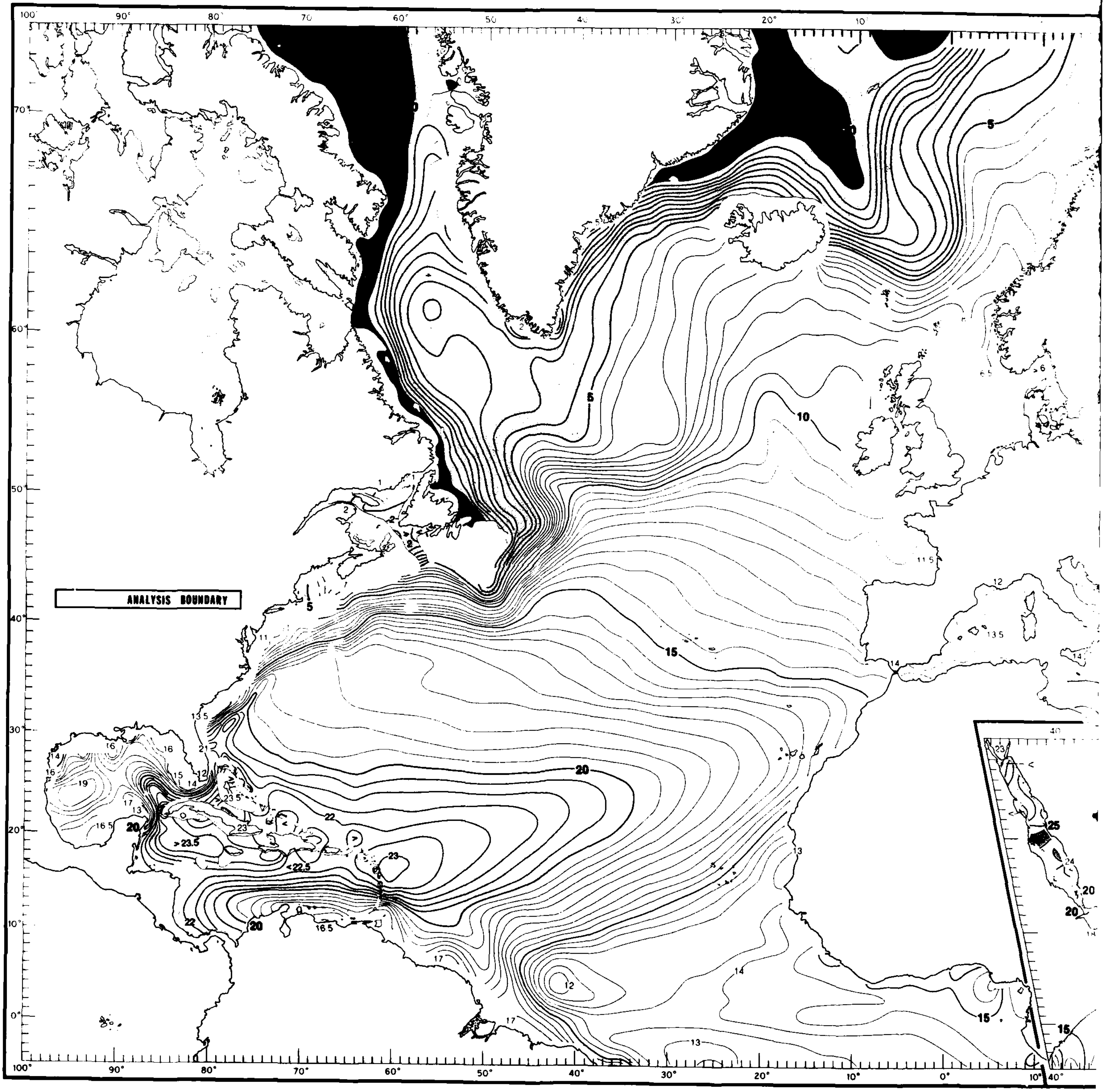
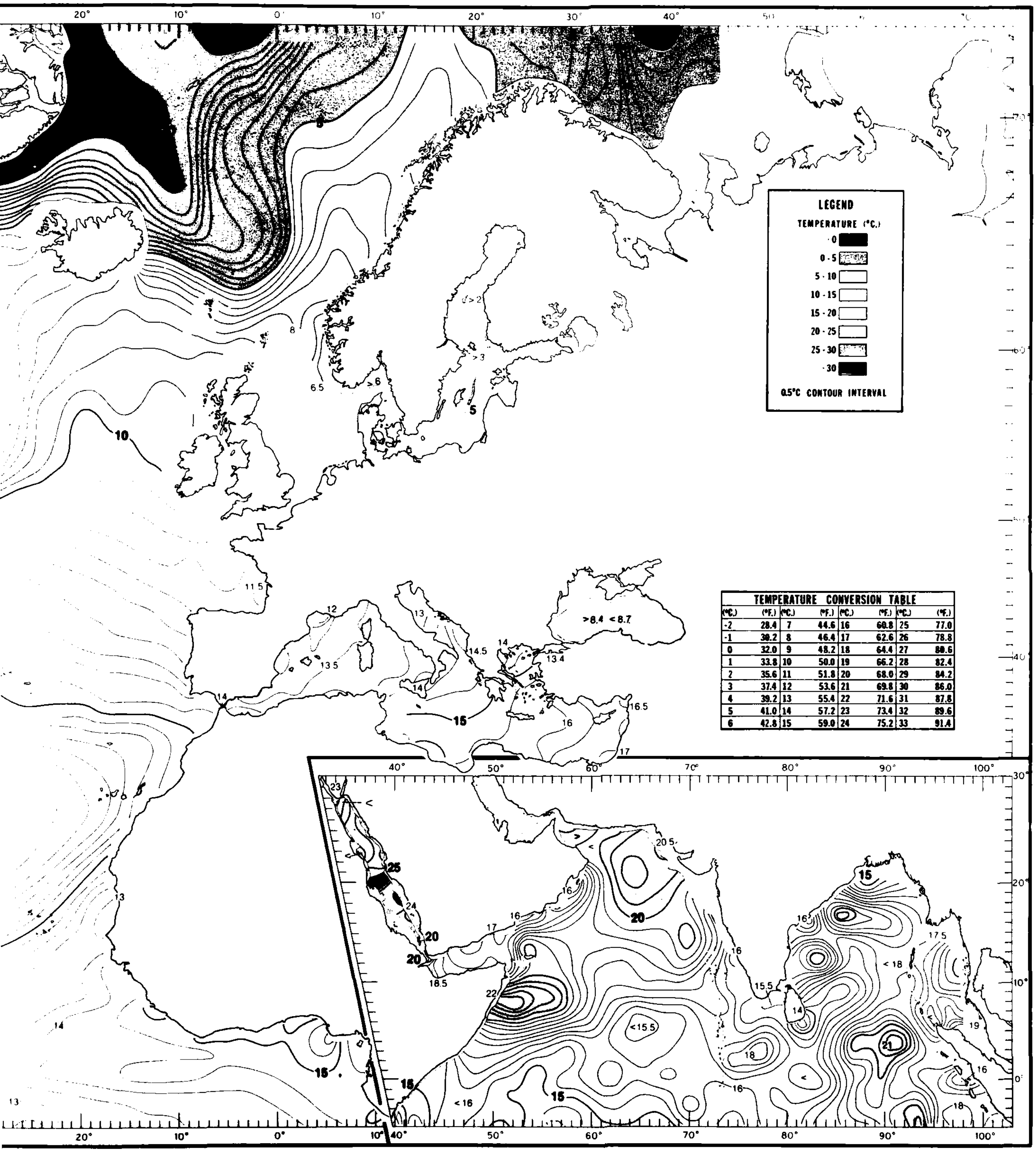


FIGURE 82. JUNE MEAN TEMPERATURES AT 492 FT (150 M)



TEMPERATURE CONVERSION TABLE							
(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

82. JUNE MEAN TEMPERATURES AT 492 FT (150 M)

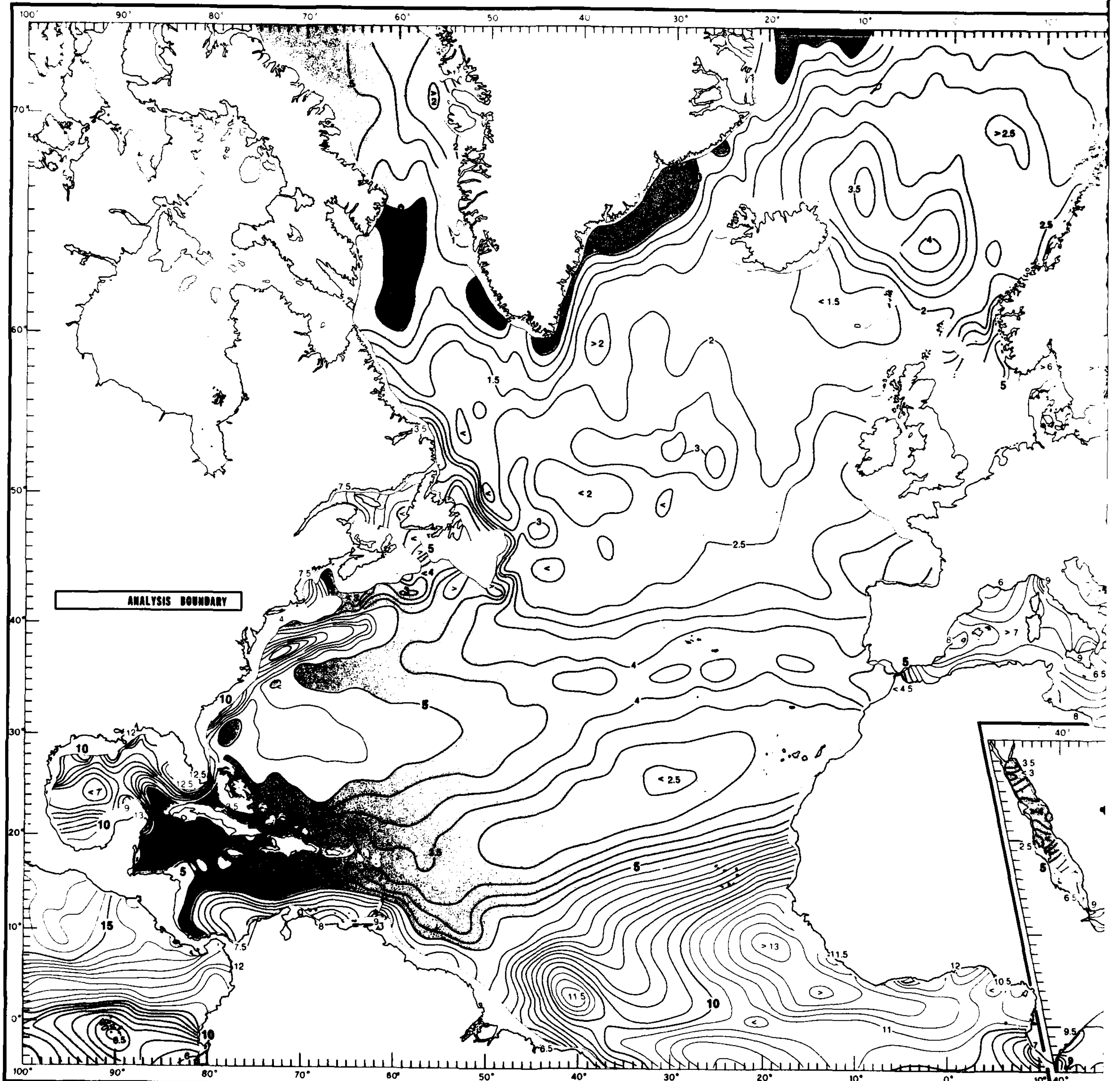
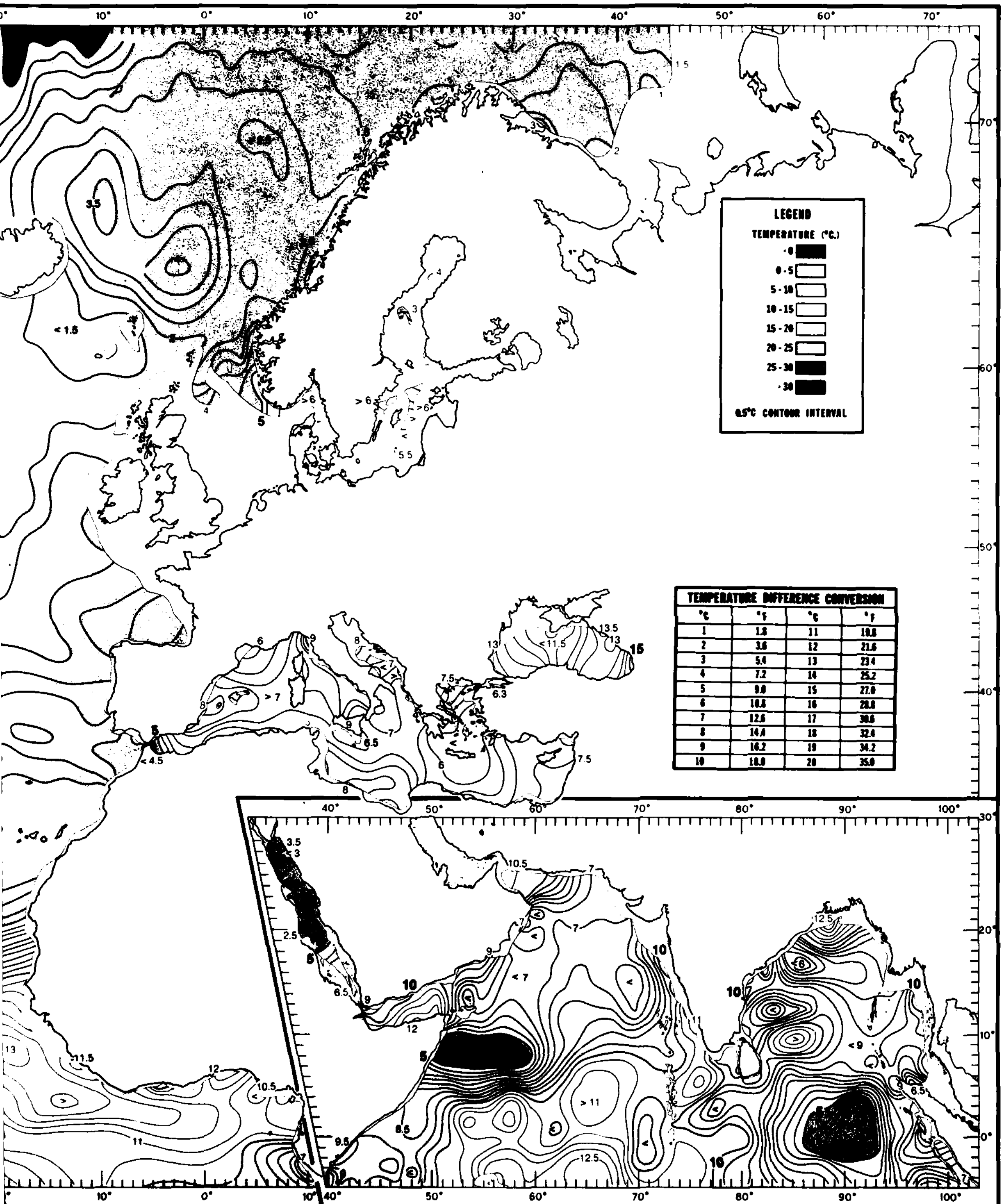


FIGURE 83. JUNE TEMPERATURE DIFFERENCE BETWEEN THE SURFACE AND 400 FT (T₀



TEMPERATURE DIFFERENCE CONVERSION			
°C	°F	°C	°F
1	1.8	11	19.8
2	3.6	12	21.6
3	5.4	13	23.4
4	7.2	14	25.2
5	9.0	15	27.0
6	10.8	16	28.8
7	12.6	17	30.6
8	14.4	18	32.4
9	16.2	19	34.2
10	18.0	20	36.0

ERENCE BETWEEN THE SURFACE AND 400 FT (T_0-T_{400})

2

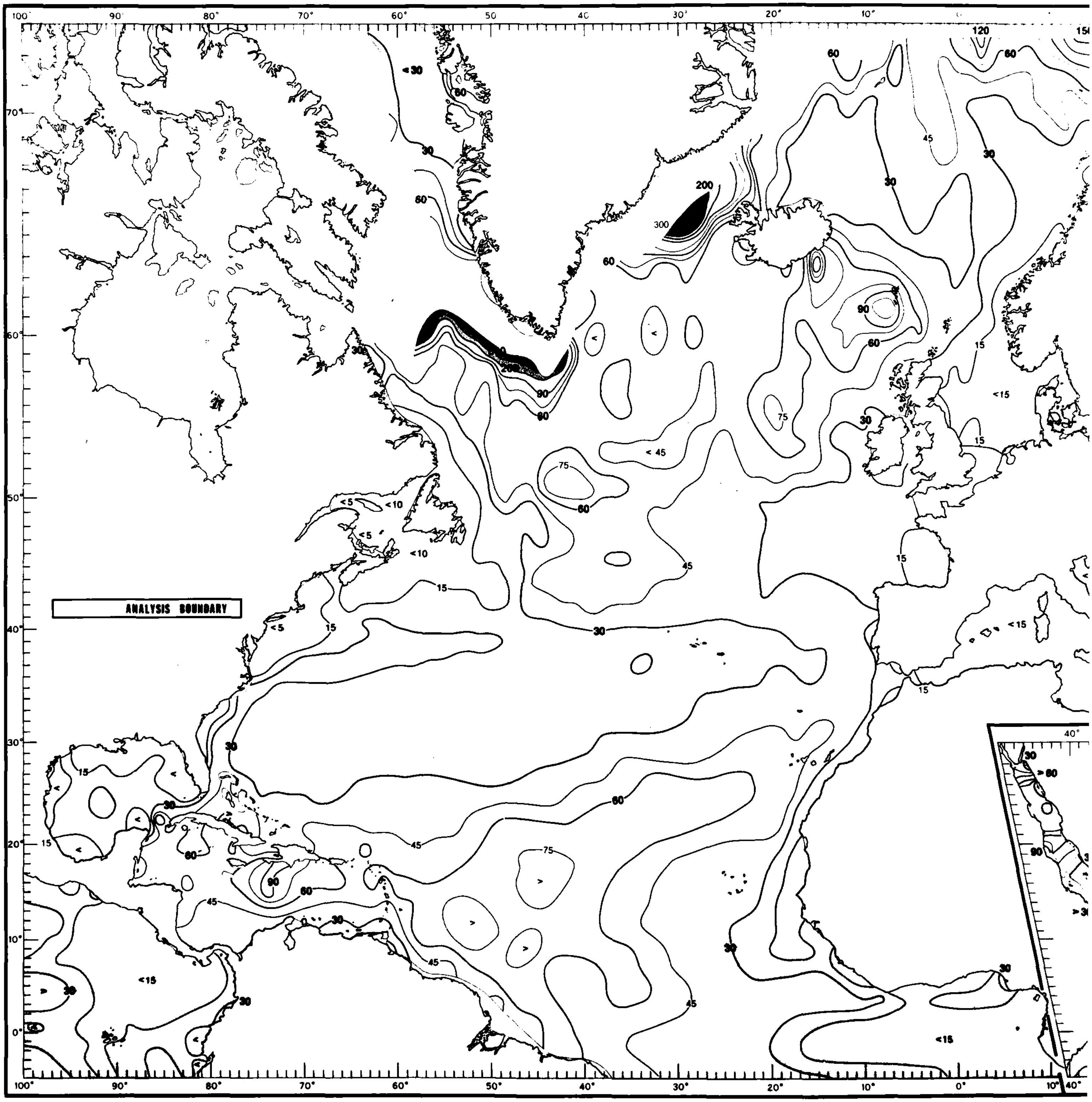
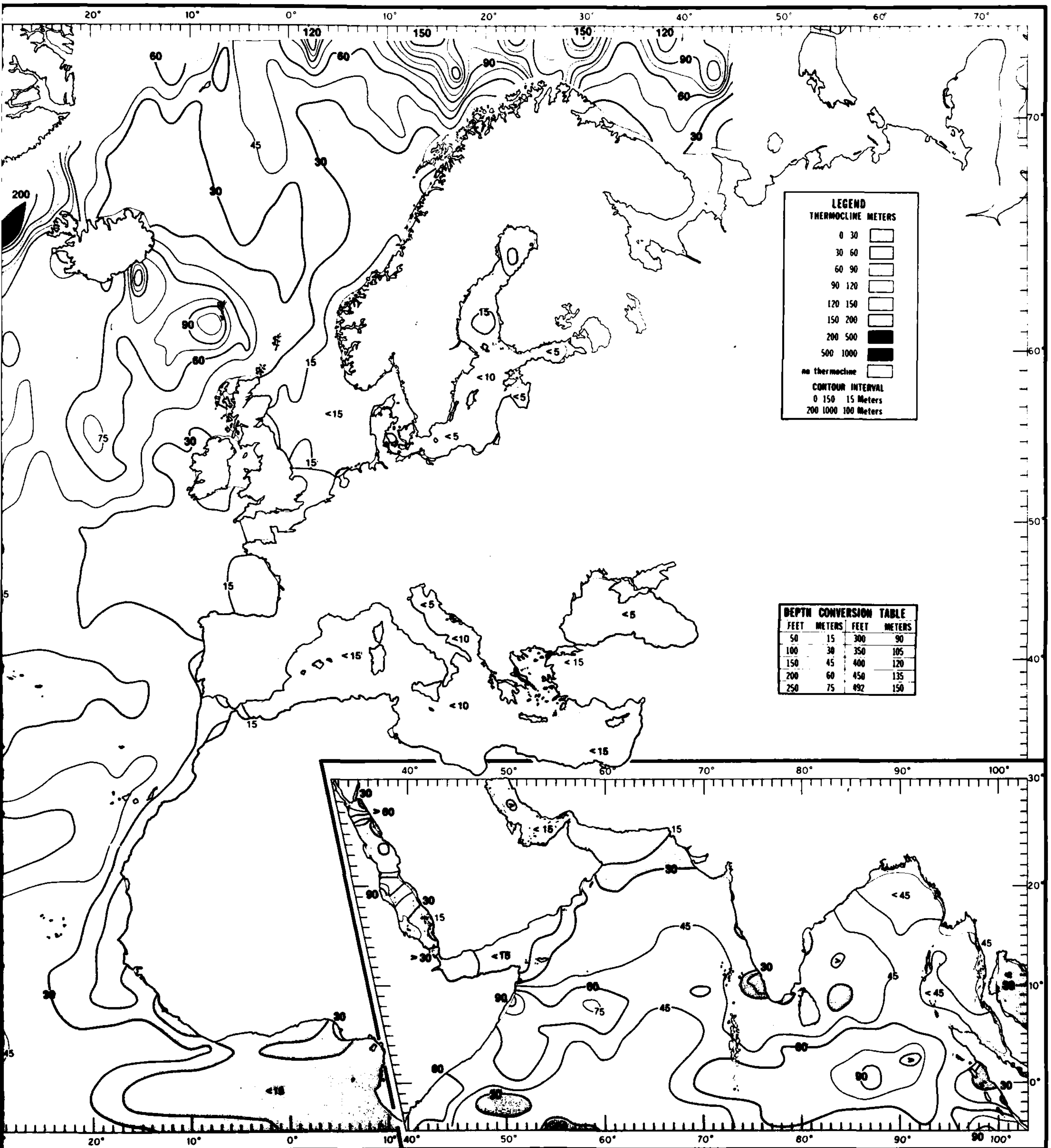


FIGURE 84. JUNE MEAN DEPTHS TO THE TOP OF THE THERMOCLINE



NE MEAN DEPTHS TO THE TOP OF THE THERMOCLINE

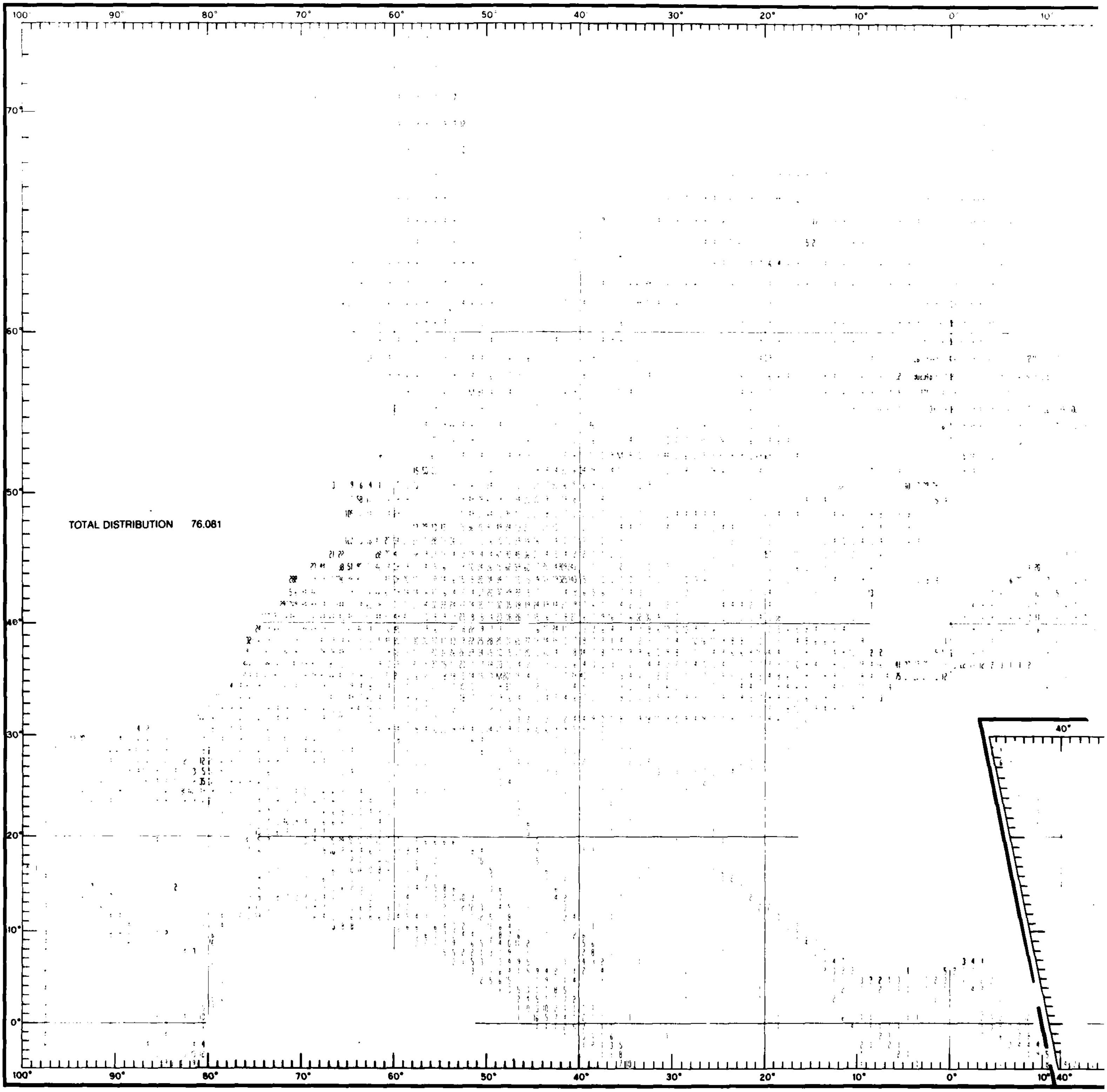
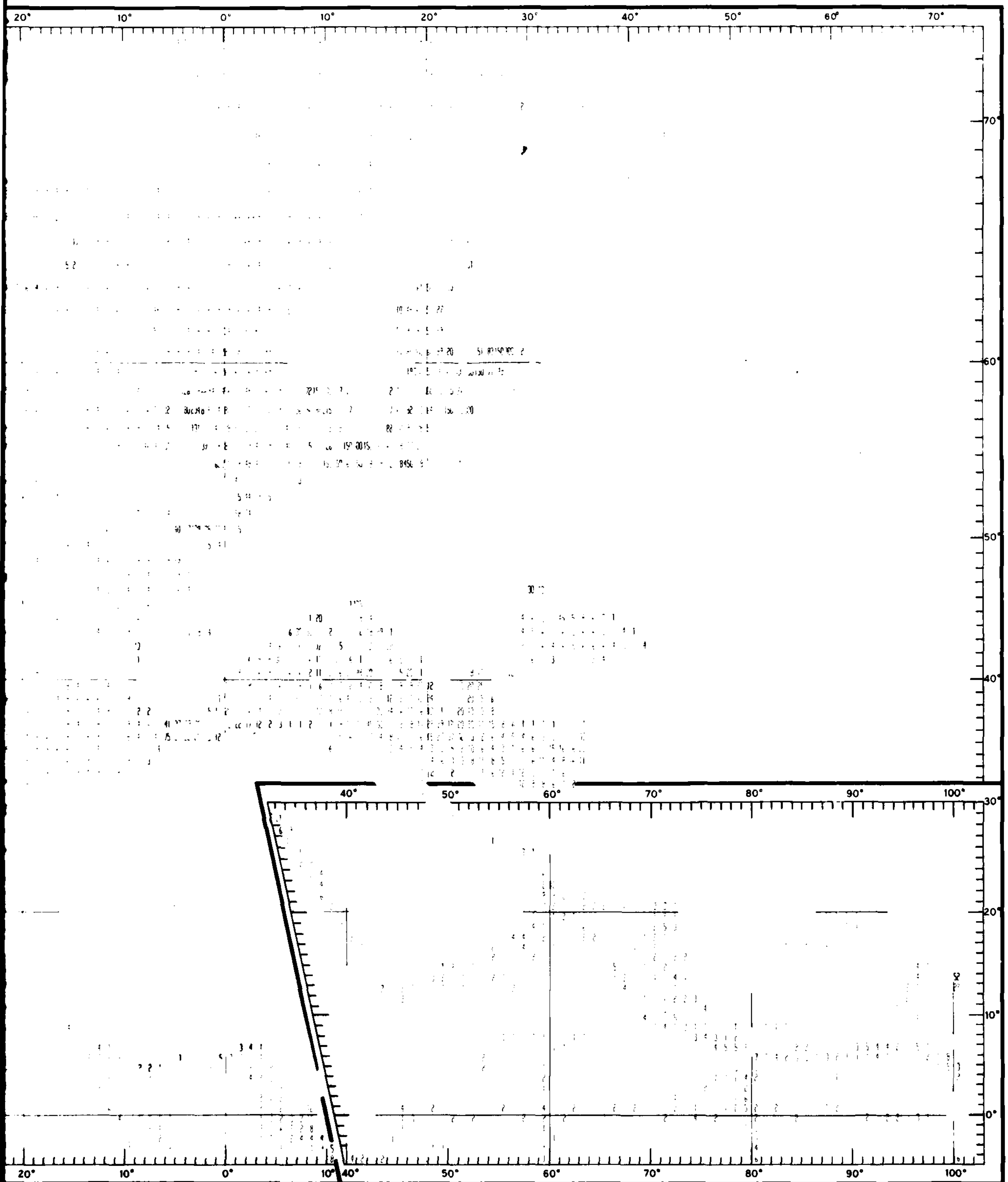


FIGURE 85. JULY DATA DISTRIBUTION OF TEMPERATURES AT THE SURFACE

1



TRIBUTION OF TEMPERATURES AT THE SURFACE

1 2

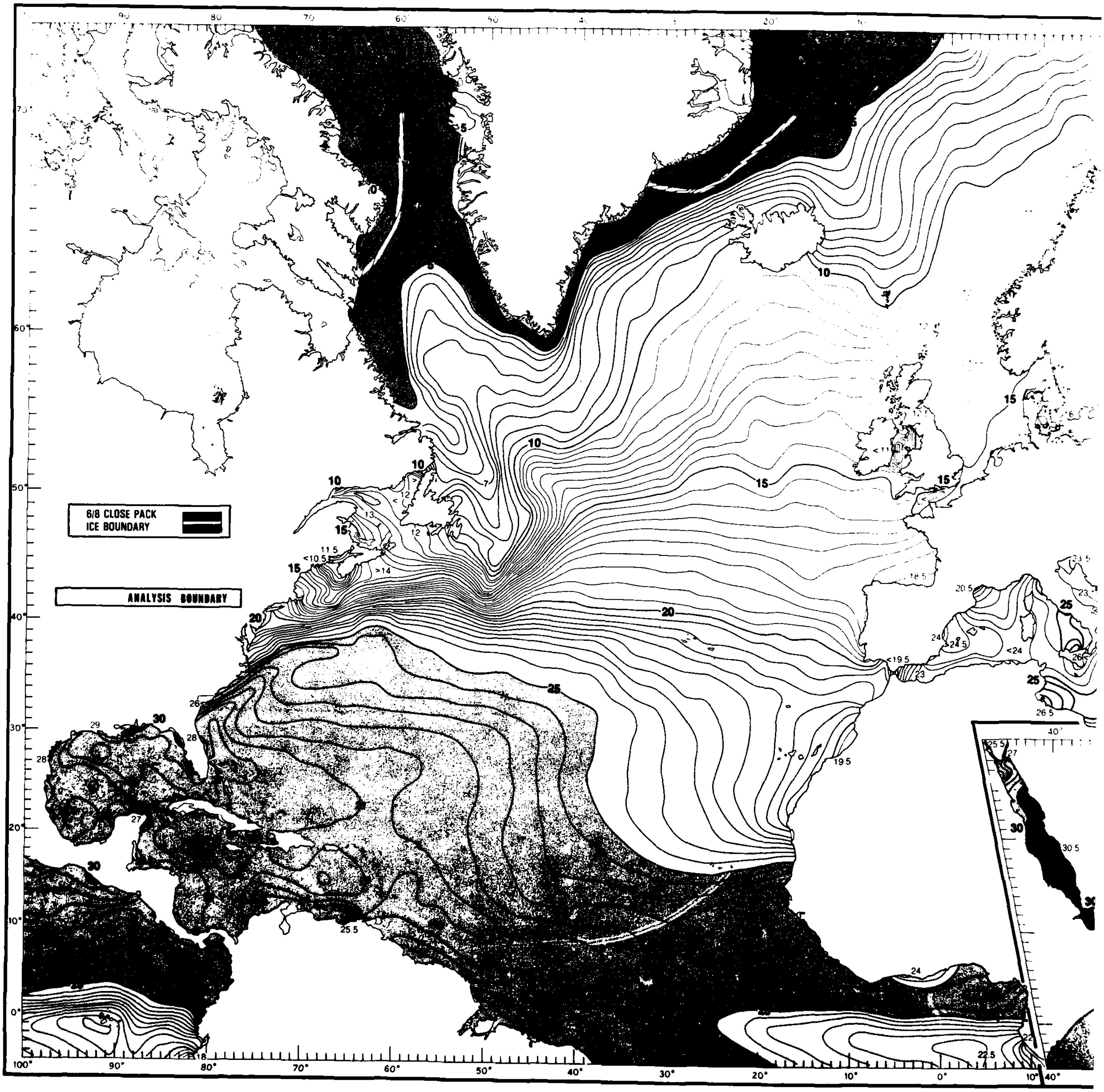
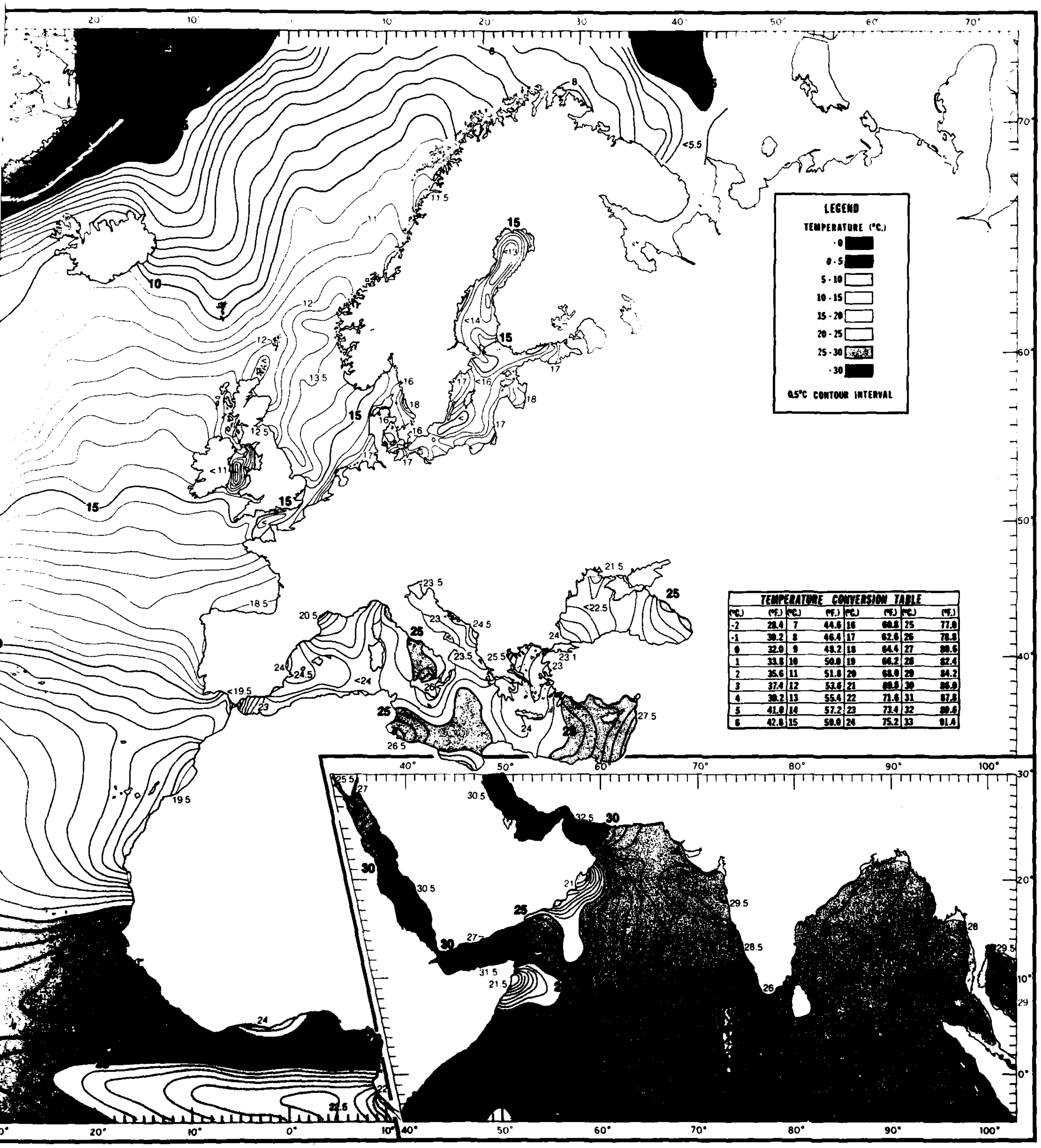


FIGURE 86. JULY MEAN TEMPERATURES AT THE SURFACE



TEMPERATURE CONVERSION TABLE							
(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

E 86. JULY MEAN TEMPERATURES AT THE SURFACE

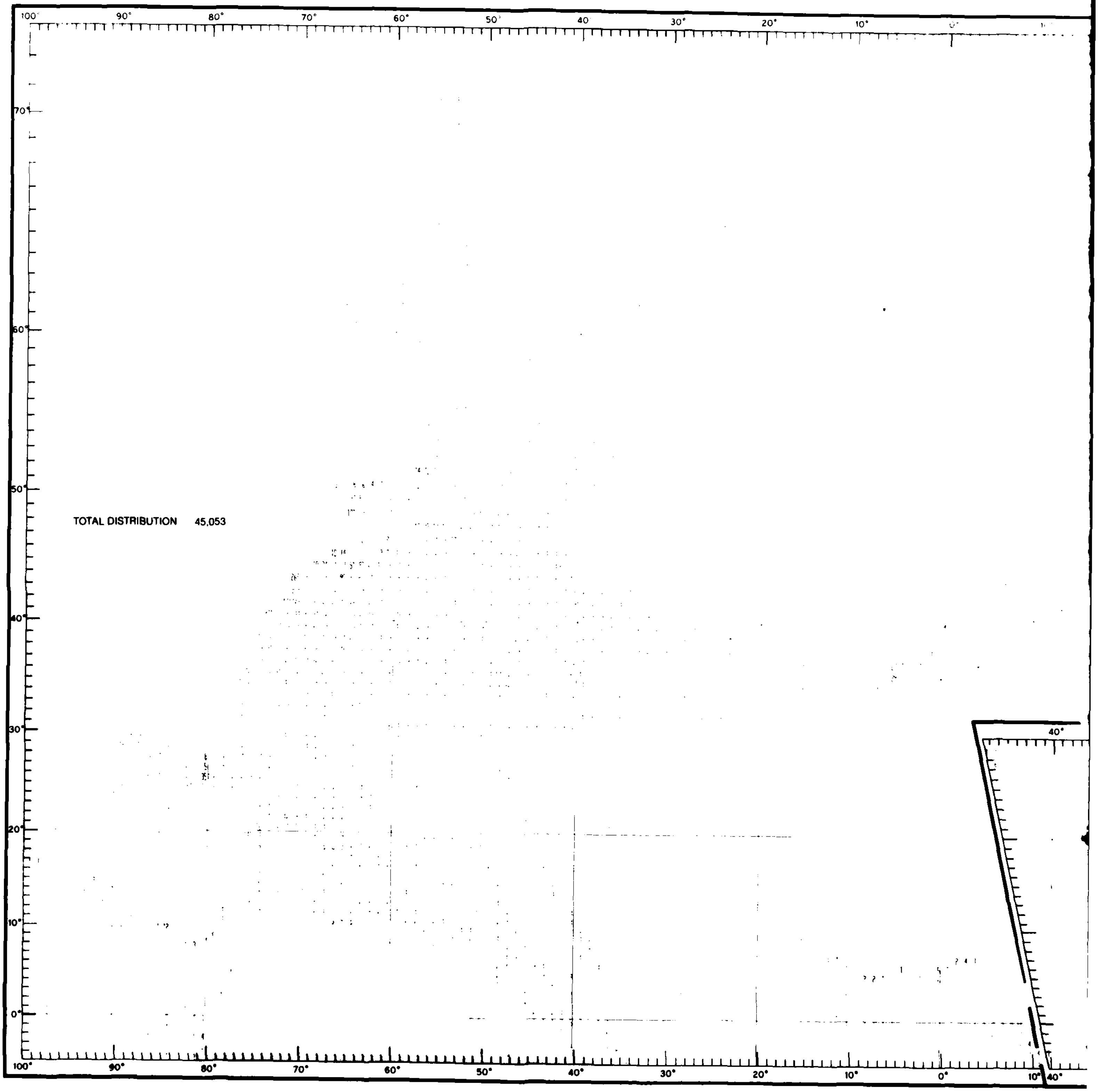
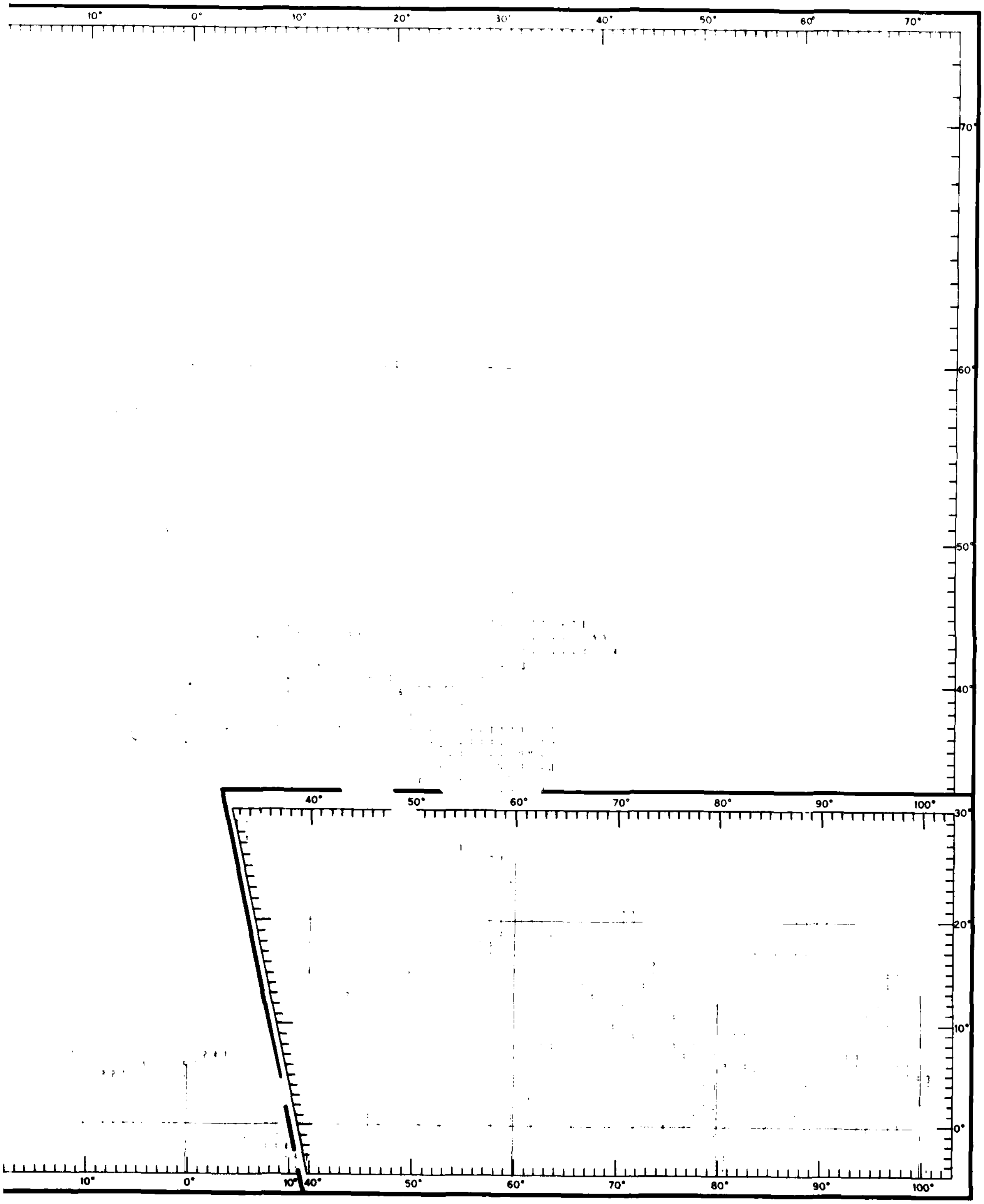


FIGURE 87. JULY DATA DISTRIBUTION OF TEMPERATURES AT 100 FT (30 M)



UTION OF TEMPERATURES AT 100 FT (30 M)

2

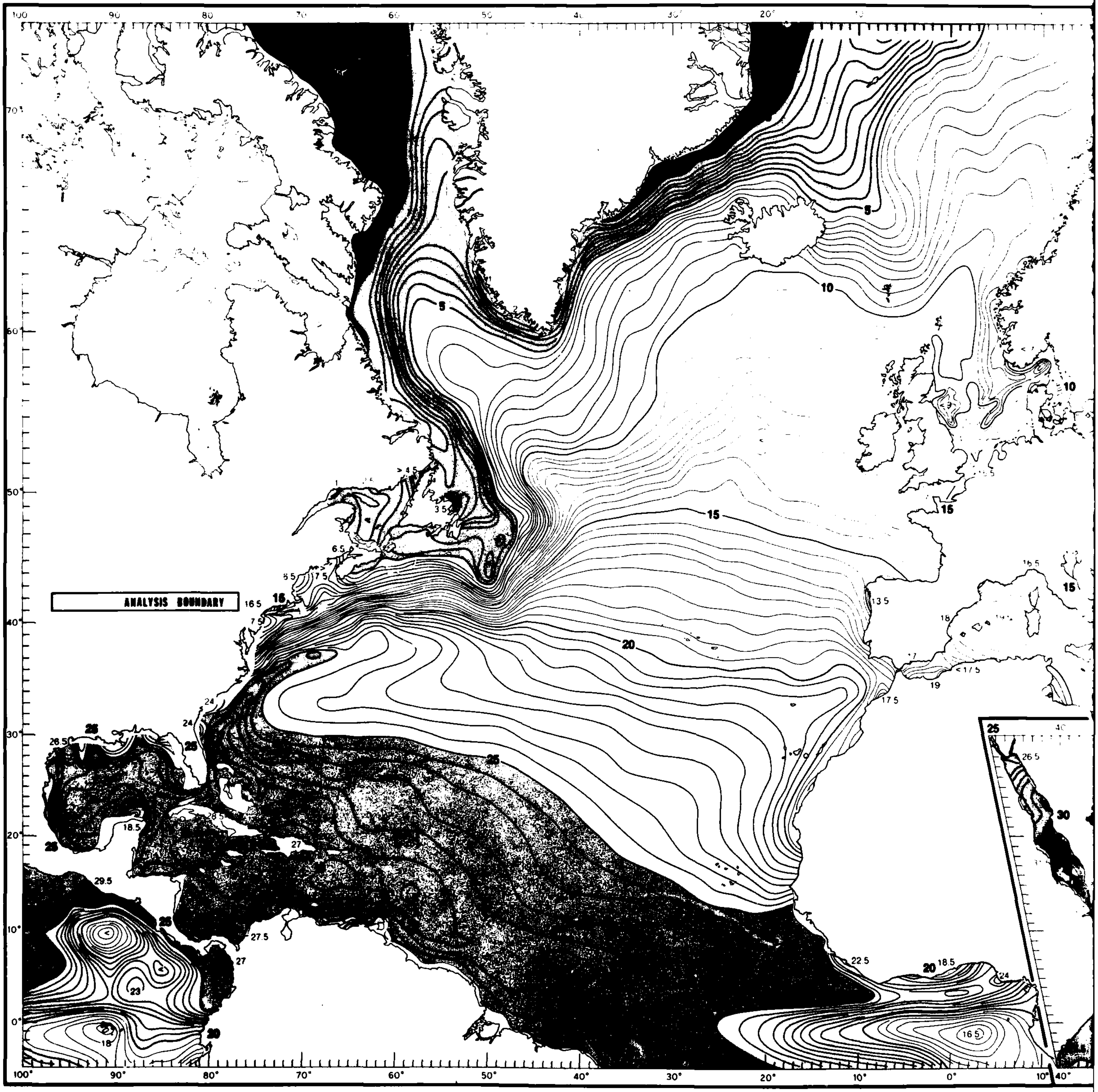
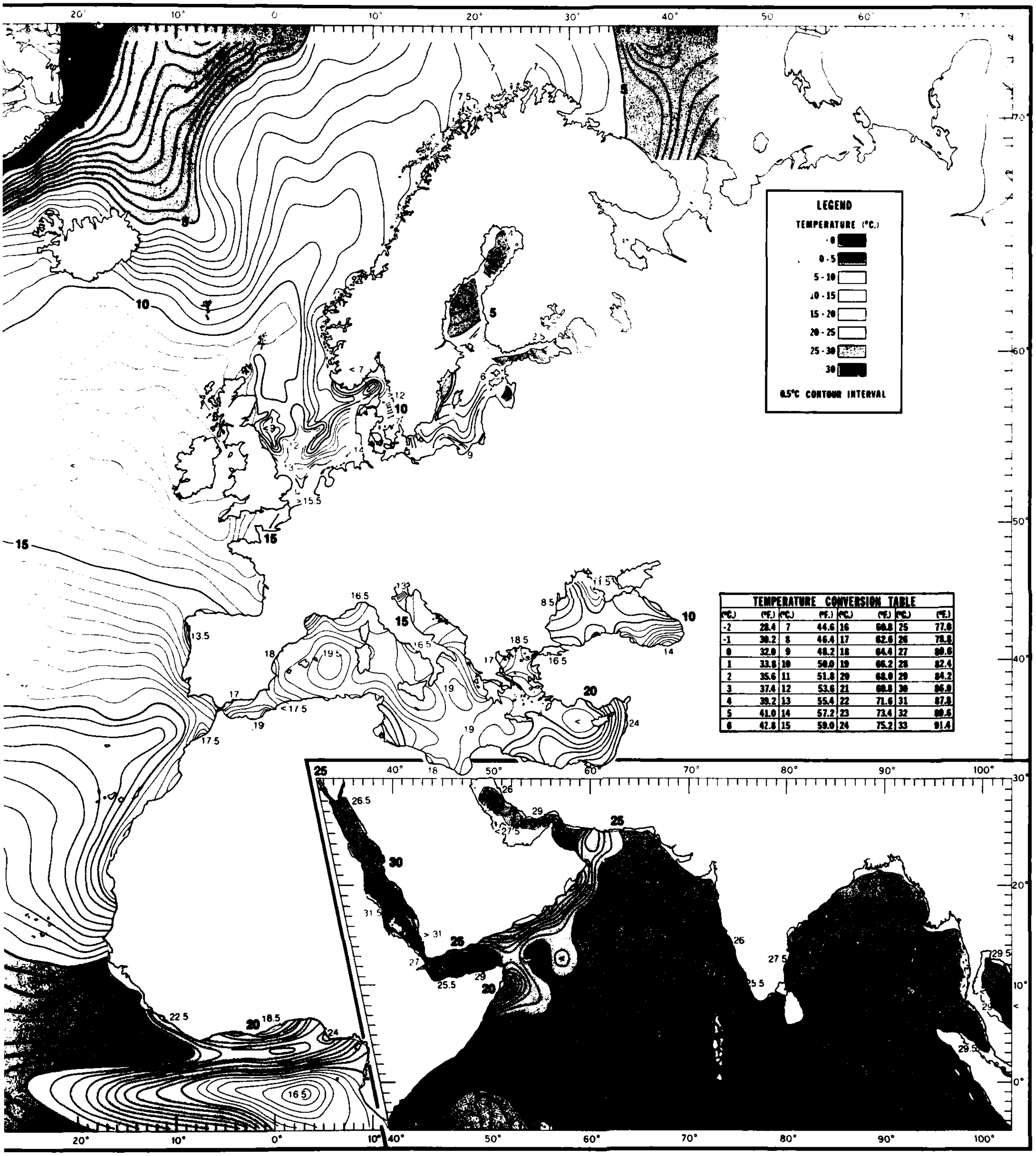


FIGURE 88. JULY MEAN TEMPERATURES AT 100 FT (30 M)



TEMPERATURE CONVERSION TABLE

(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

JULY MEAN TEMPERATURES AT 100 FT (30 M)

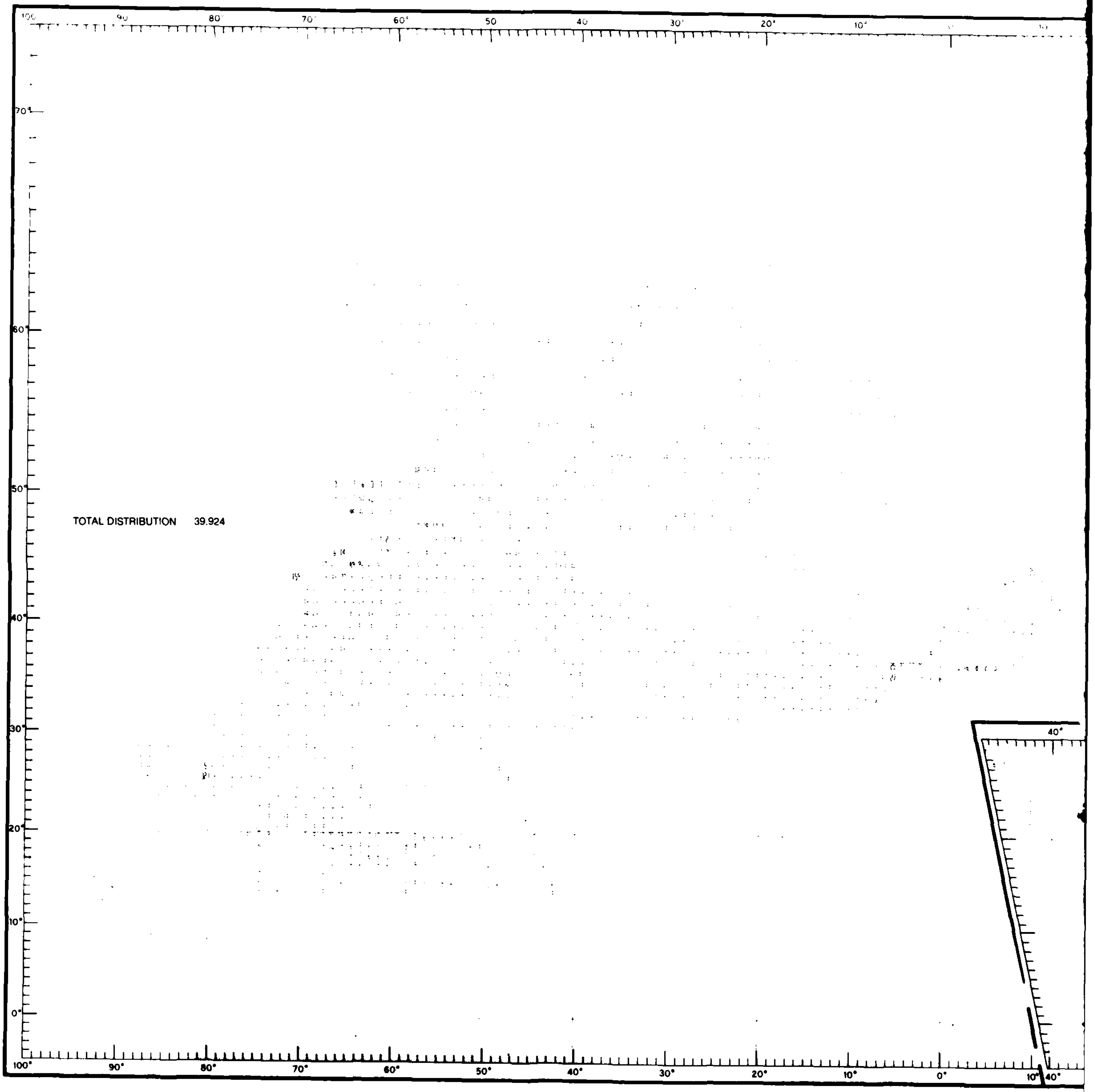
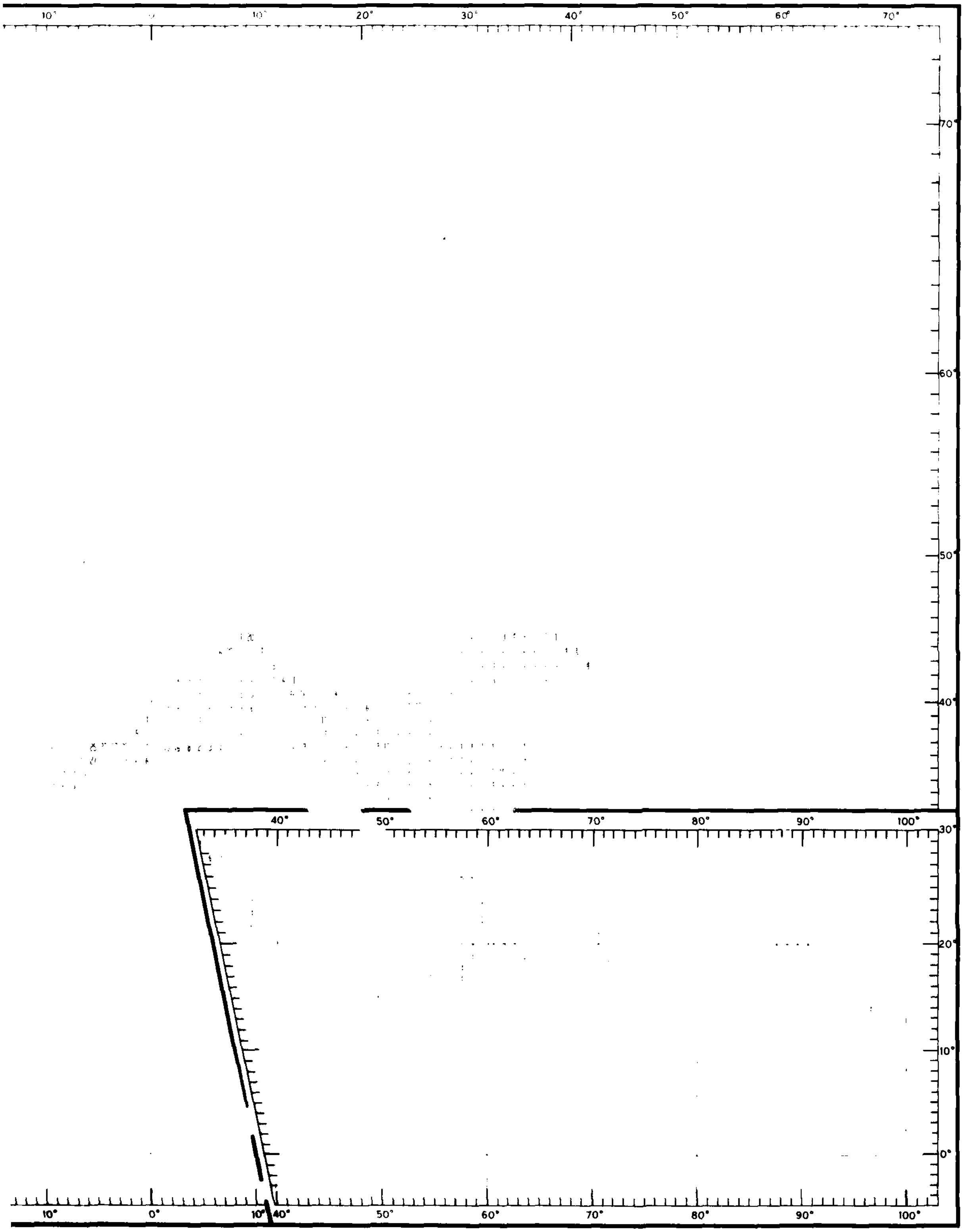


FIGURE 89. JULY DATA DISTRIBUTION OF TEMPERATURES AT 200 FT (60 M)



OF TEMPERATURES AT 200 FT (60 M)

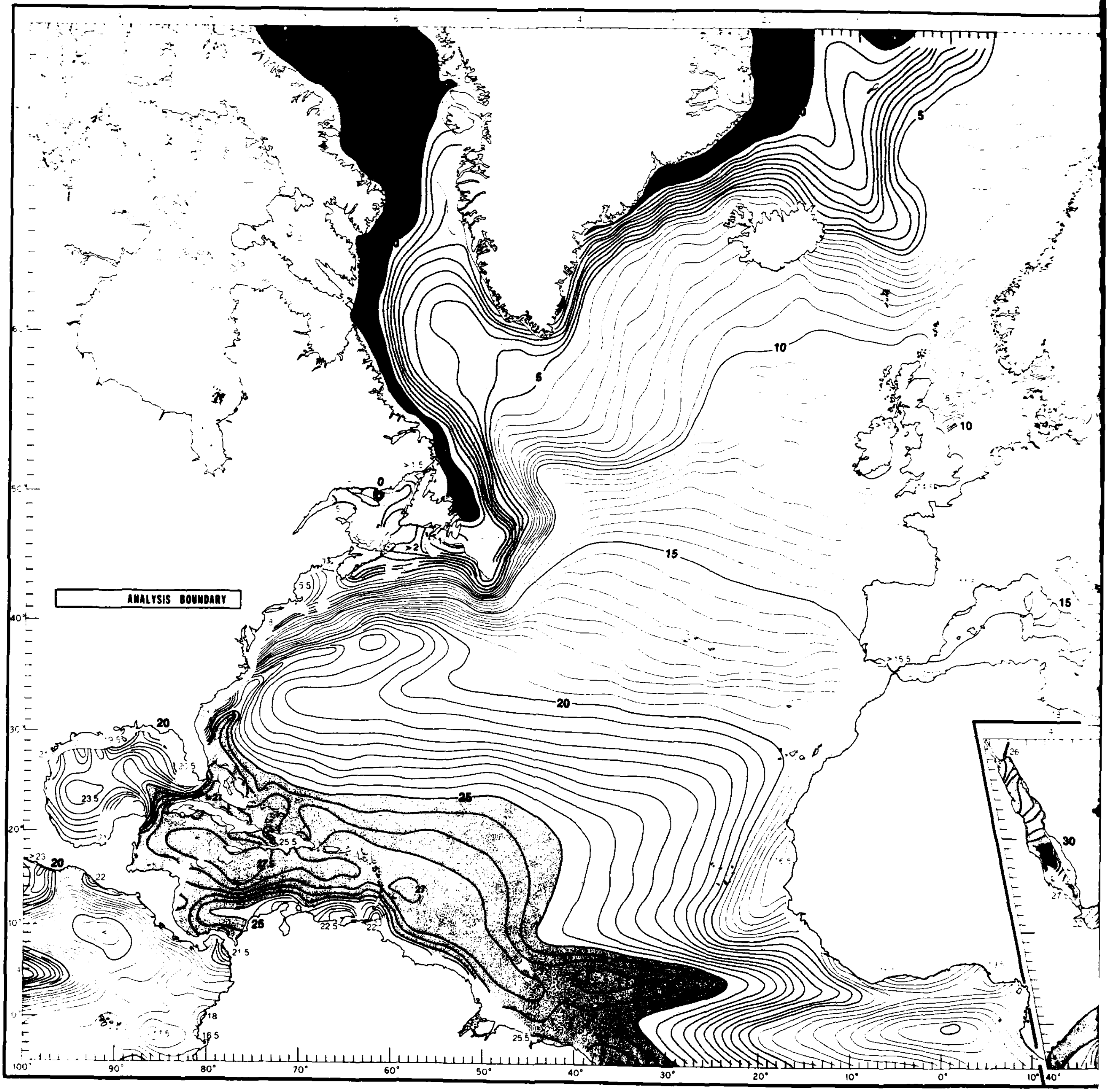
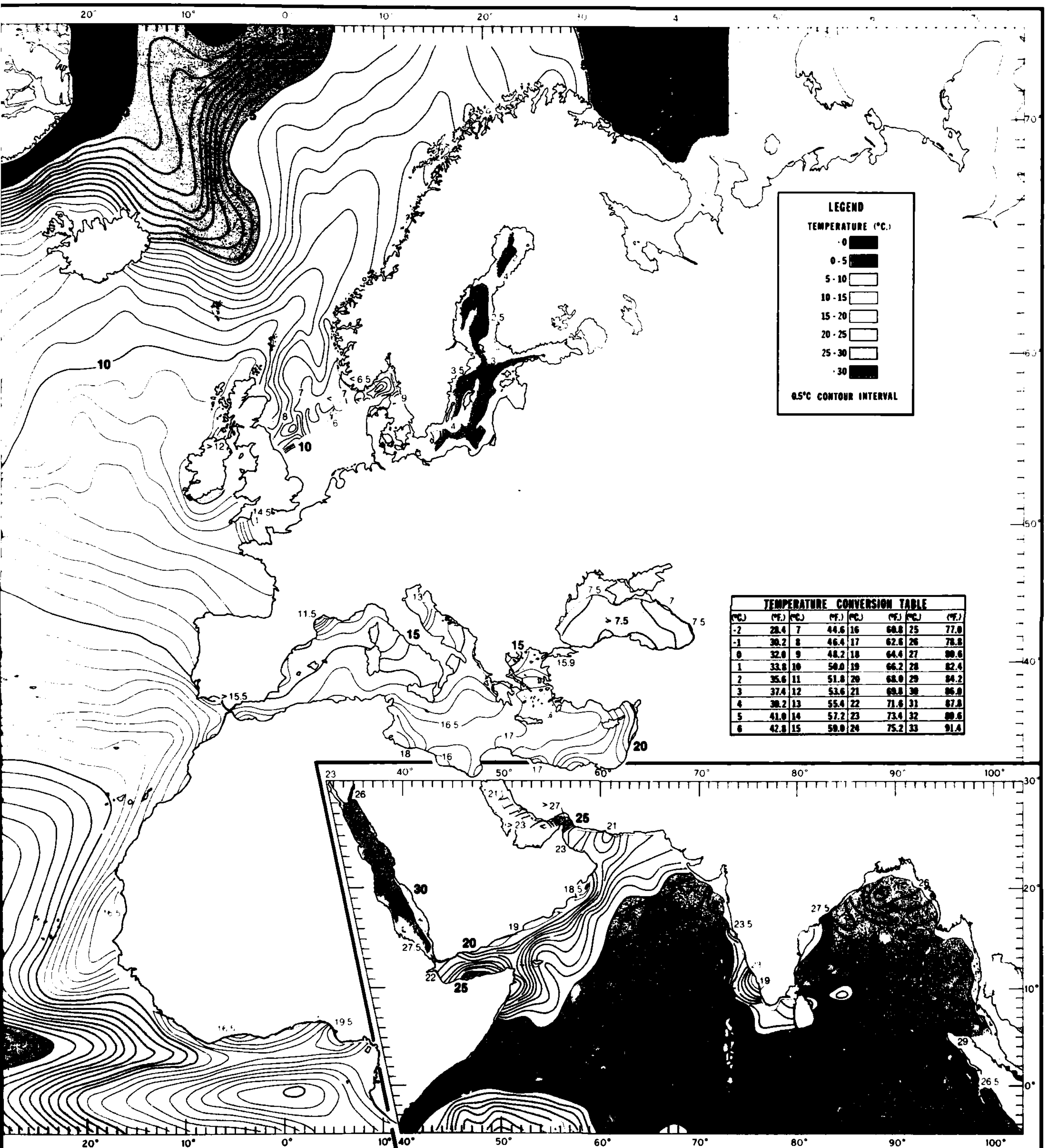


FIGURE 90. JULY MEAN TEMPERATURES AT 200 FT (60 M)



TEMPERATURE CONVERSION TABLE							
(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

90. JULY MEAN TEMPERATURES AT 200 FT (60 M)

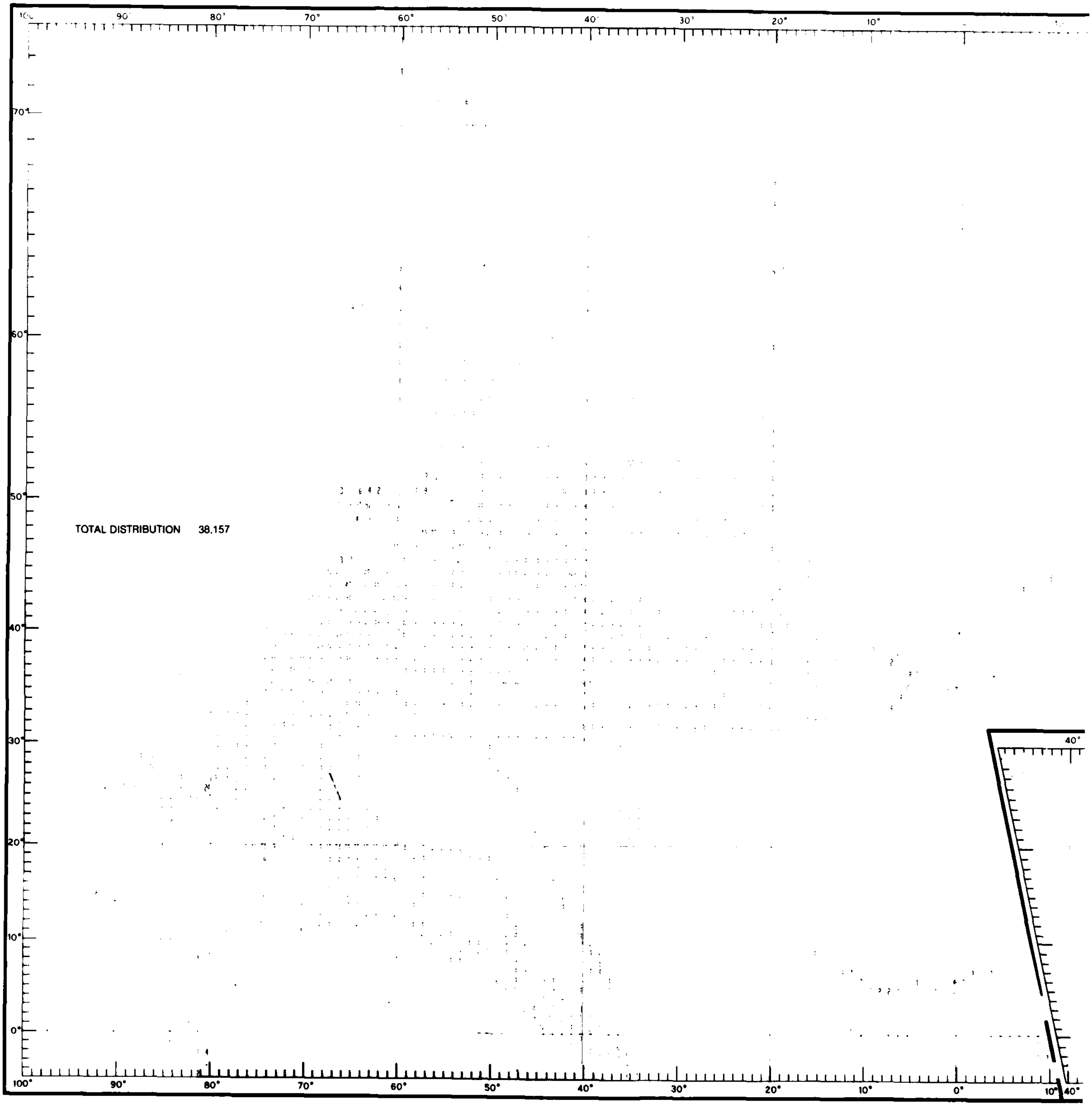
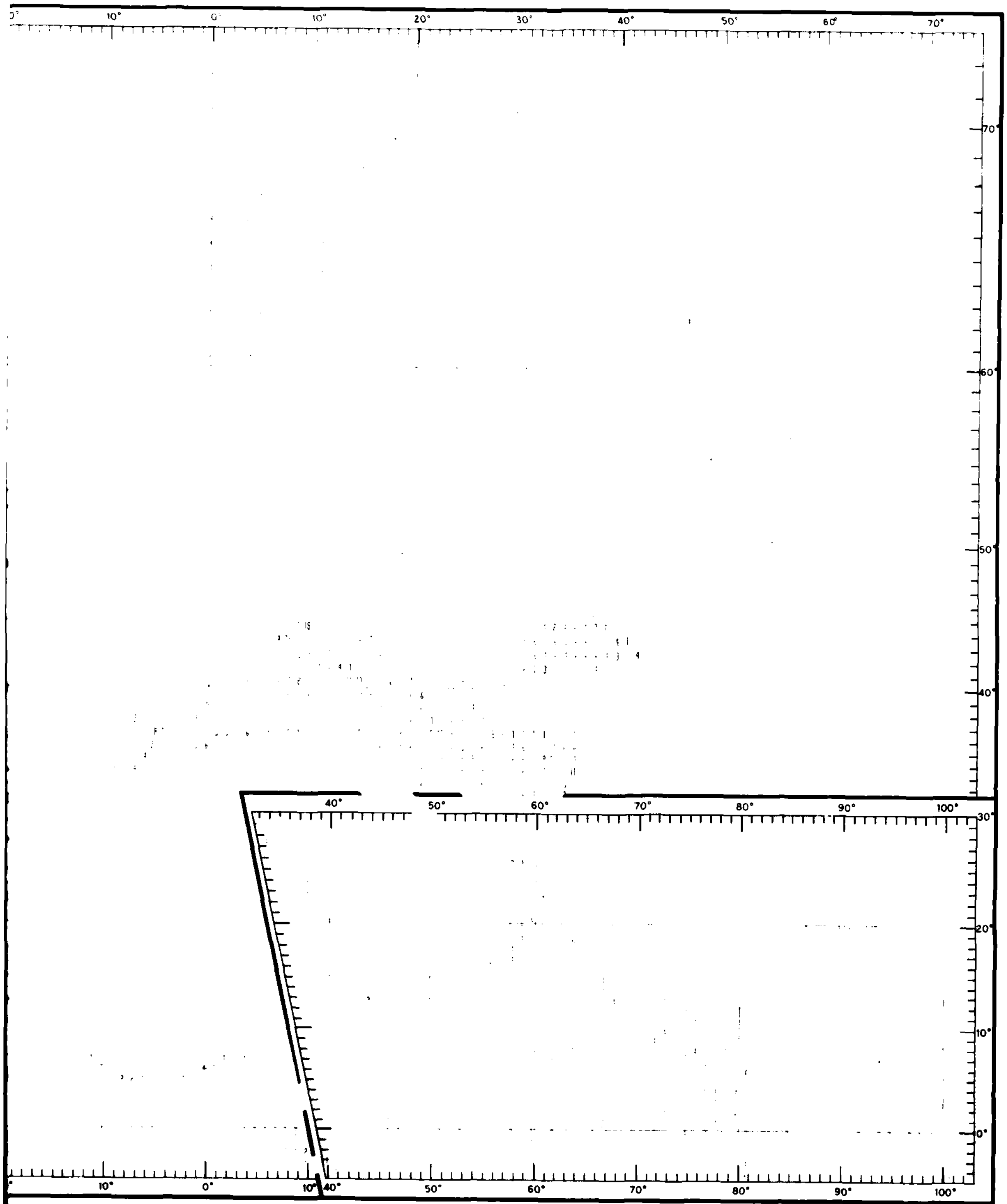


FIGURE 91. JULY DATA DISTRIBUTION OF TEMPERATURES AT 300 FT (90 M



IBUTION OF TEMPERATURES AT 300 FT (90 M)

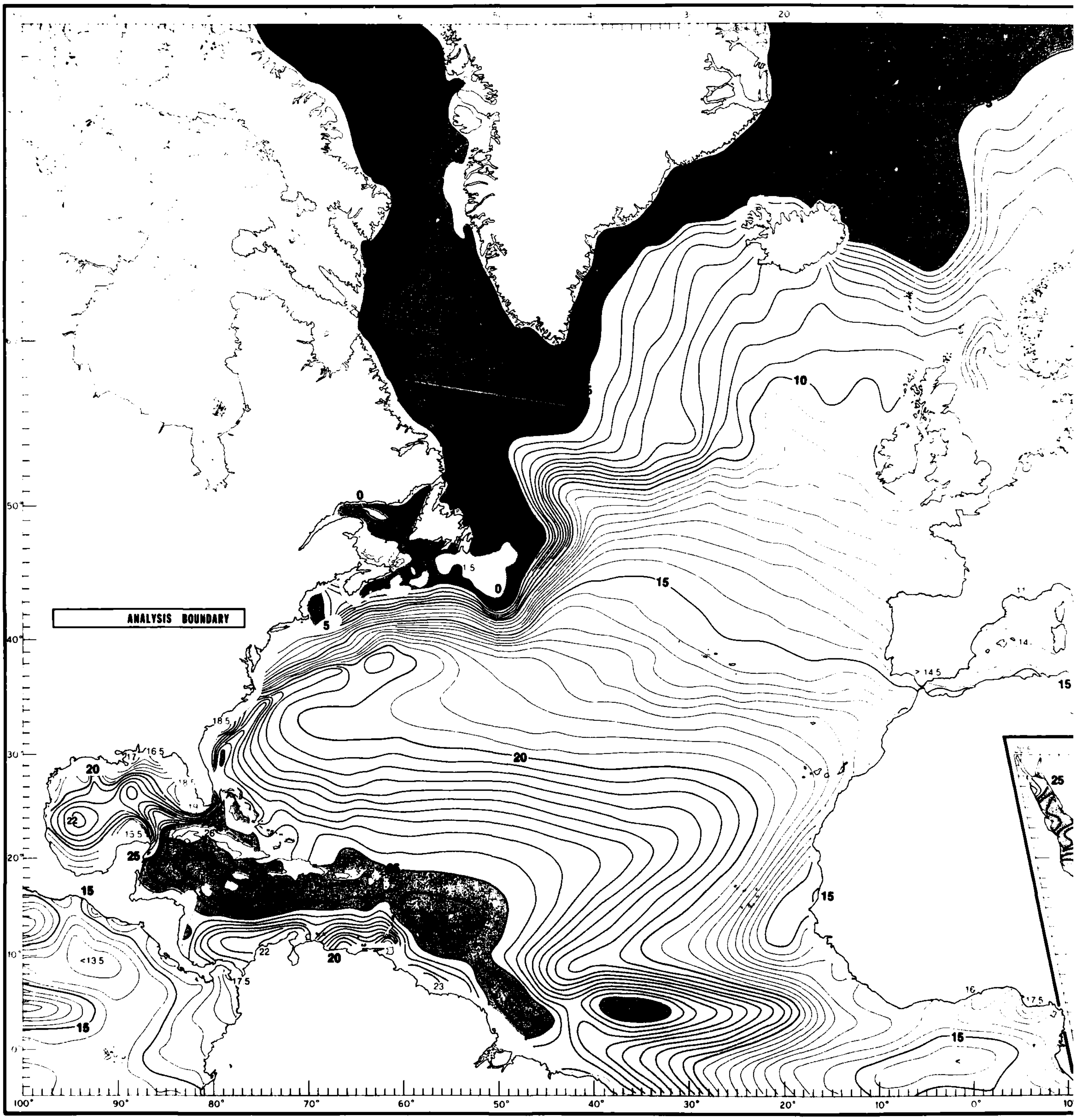
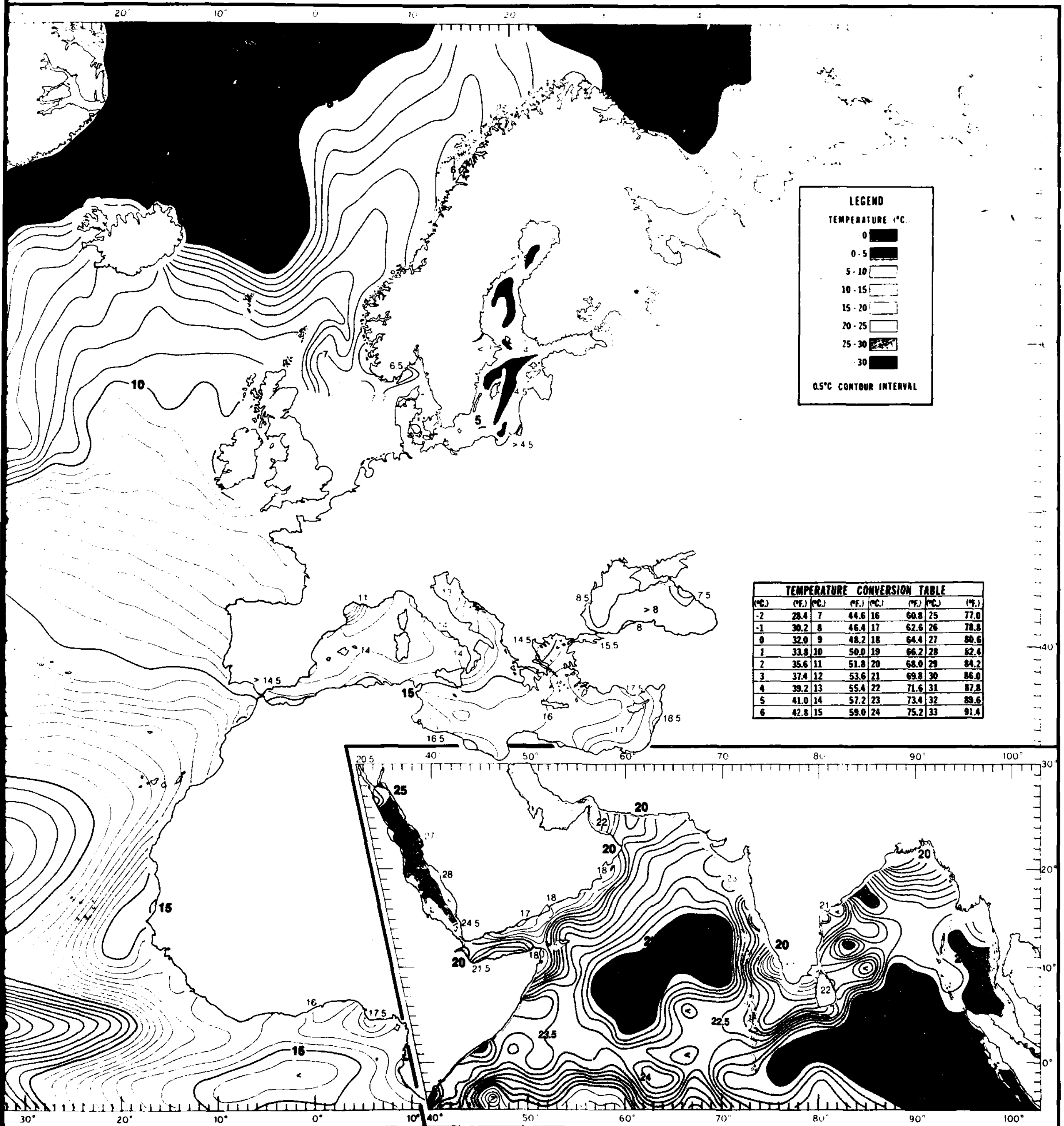


FIGURE 92. JULY MEAN TEMPERATURES AT 300 FT (90 M)



TEMPERATURE CONVERSION TABLE

(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

GURE 92. JULY MEAN TEMPERATURES AT 300 FT (90 M)

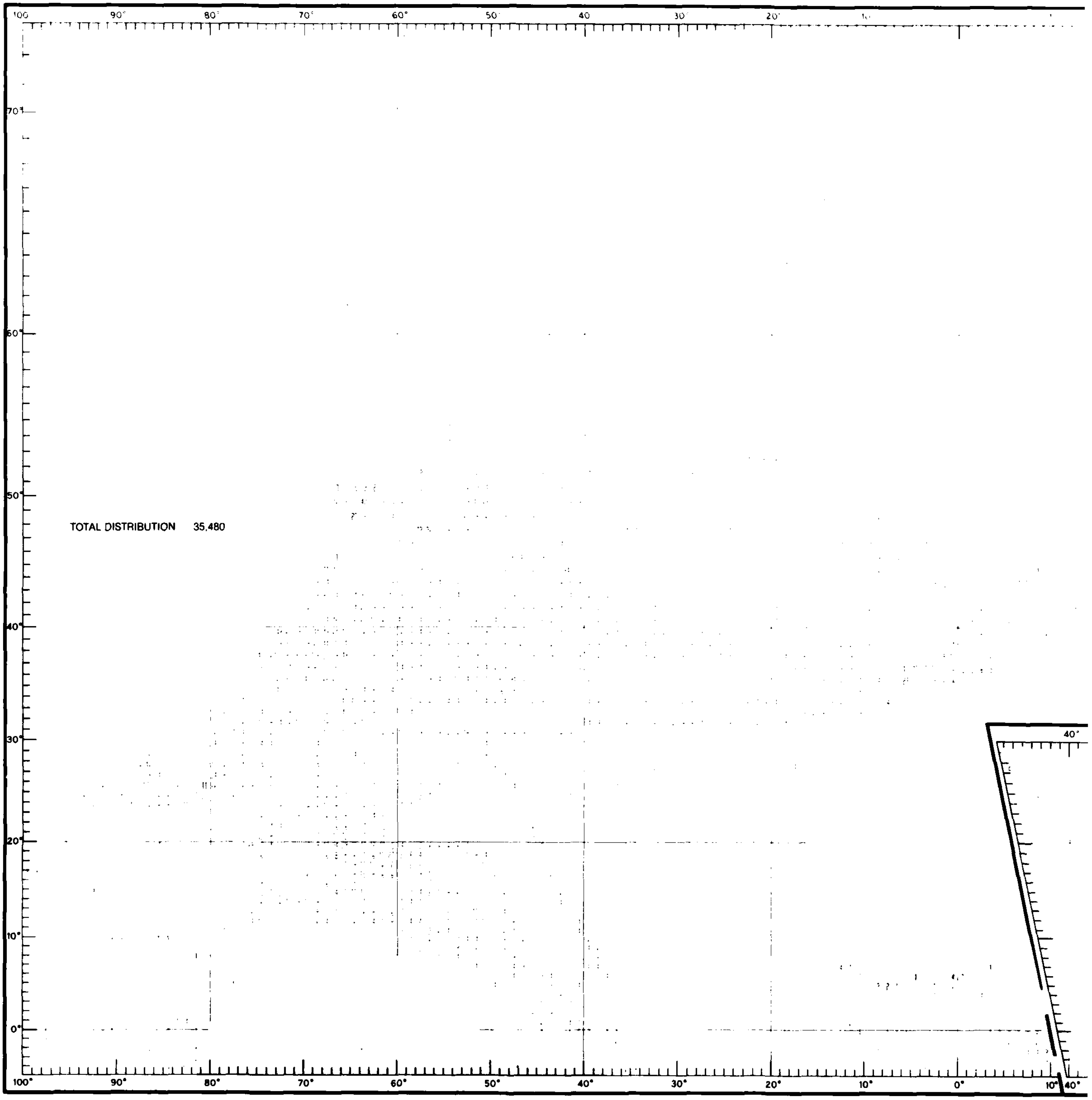
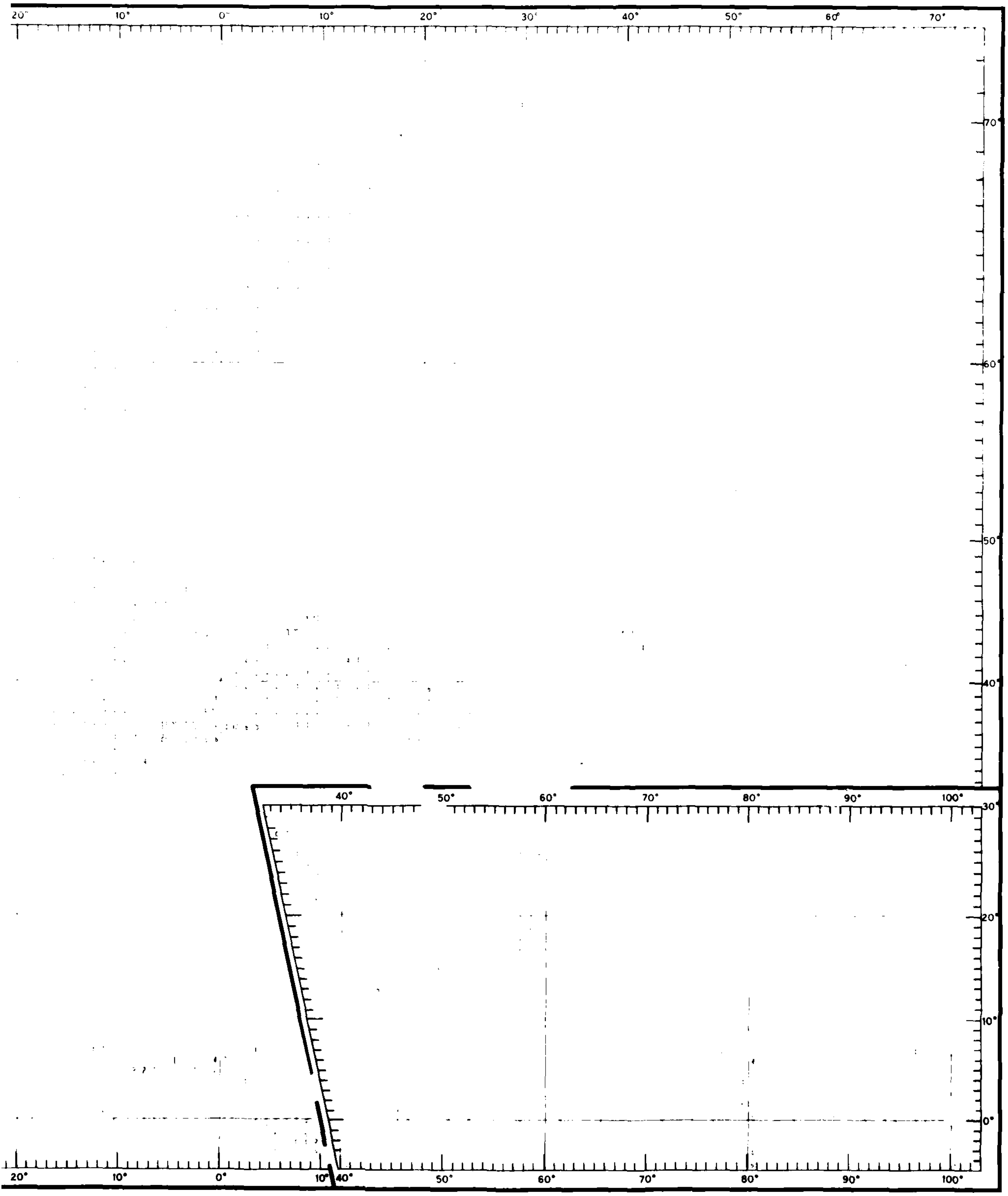


FIGURE 93. JULY DATA DISTRIBUTION OF TEMPERATURES AT 400 FT (120 M



'RIBUTION OF TEMPERATURES AT 400 FT (120 M)

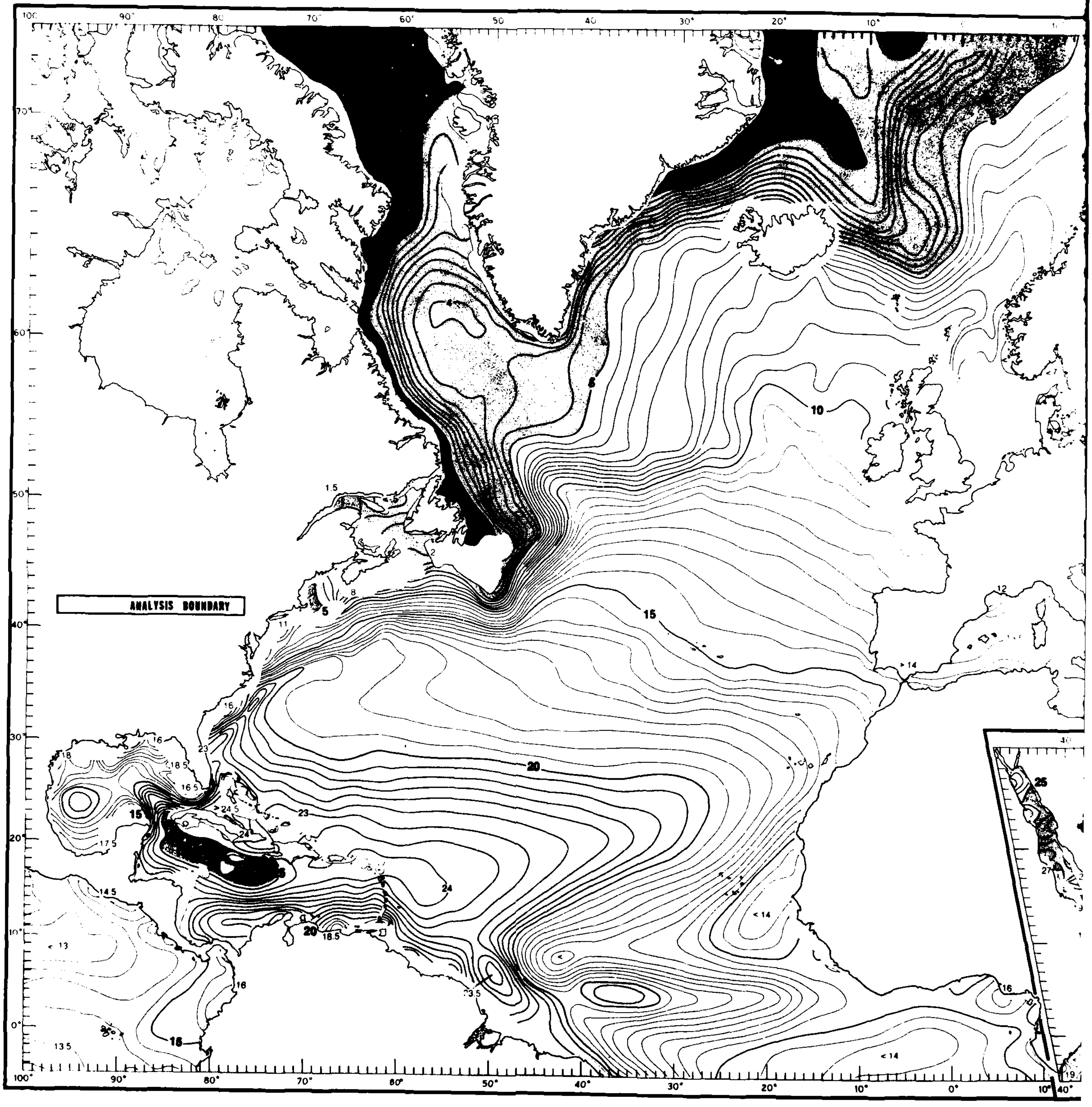
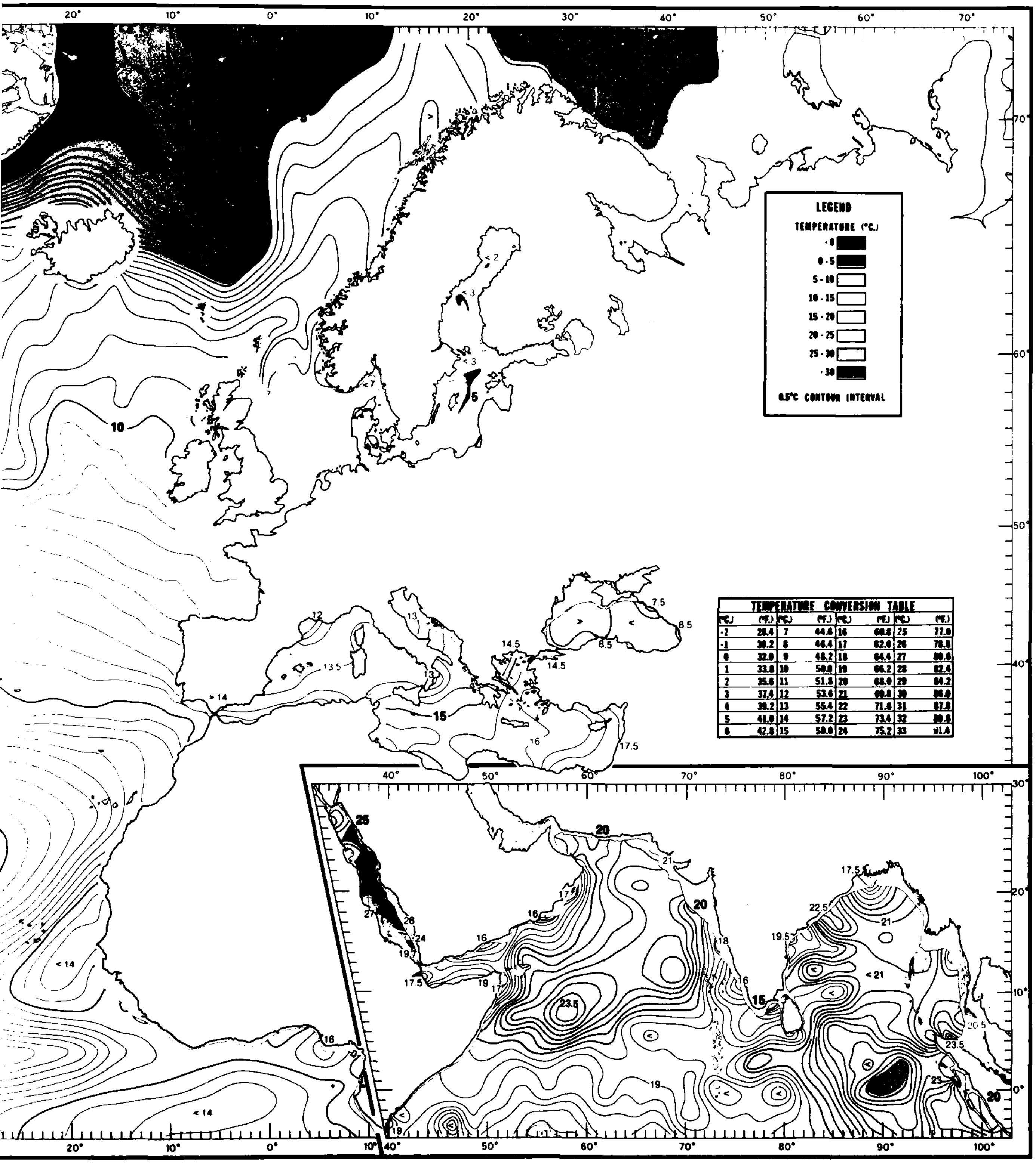


FIGURE 94. JULY MEAN TEMPERATURES AT 400 FT (120 M)



TEMPERATURE CONVERSION TABLE

(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

94. JULY MEAN TEMPERATURES AT 400 FT (120 M)

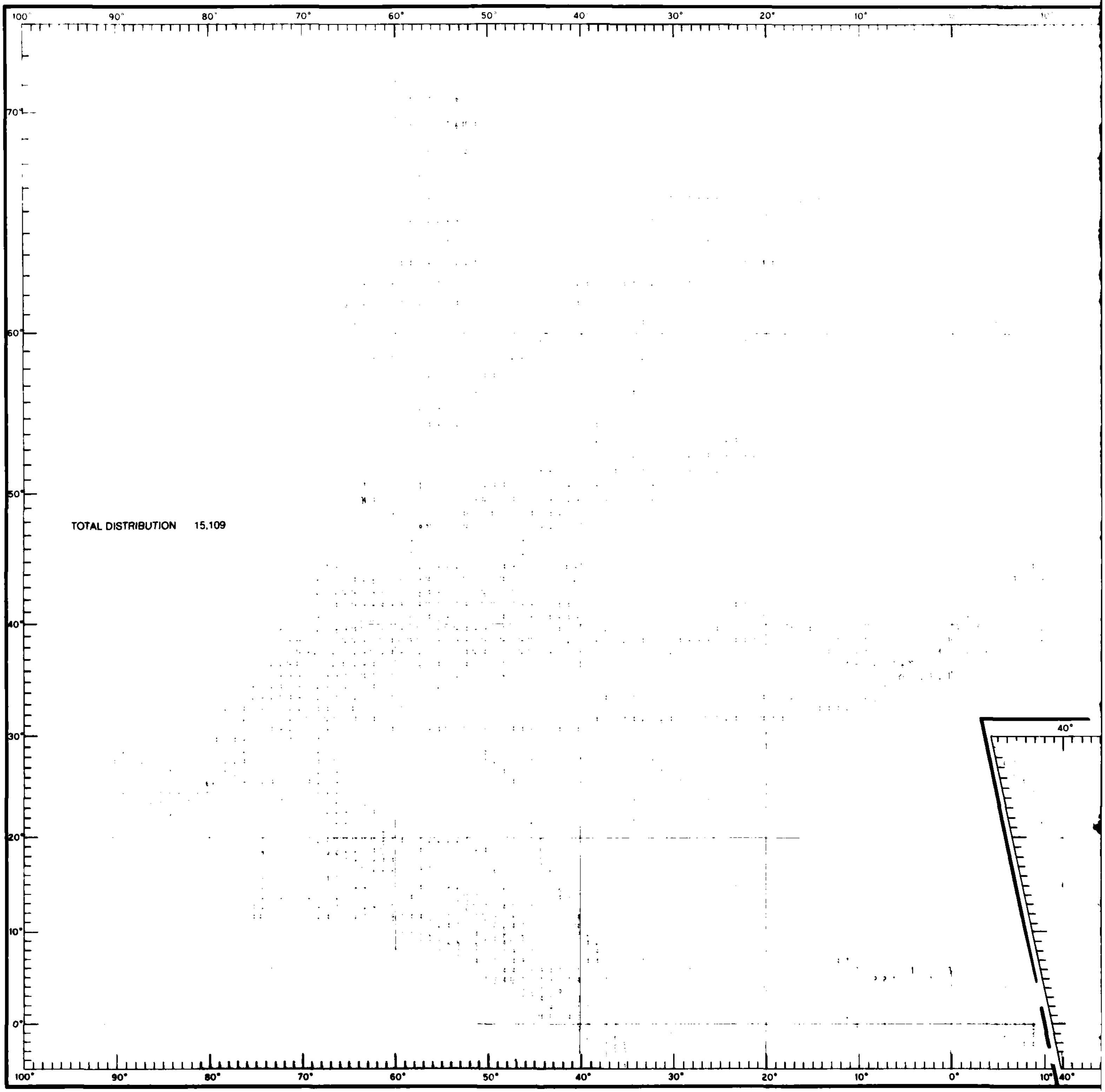
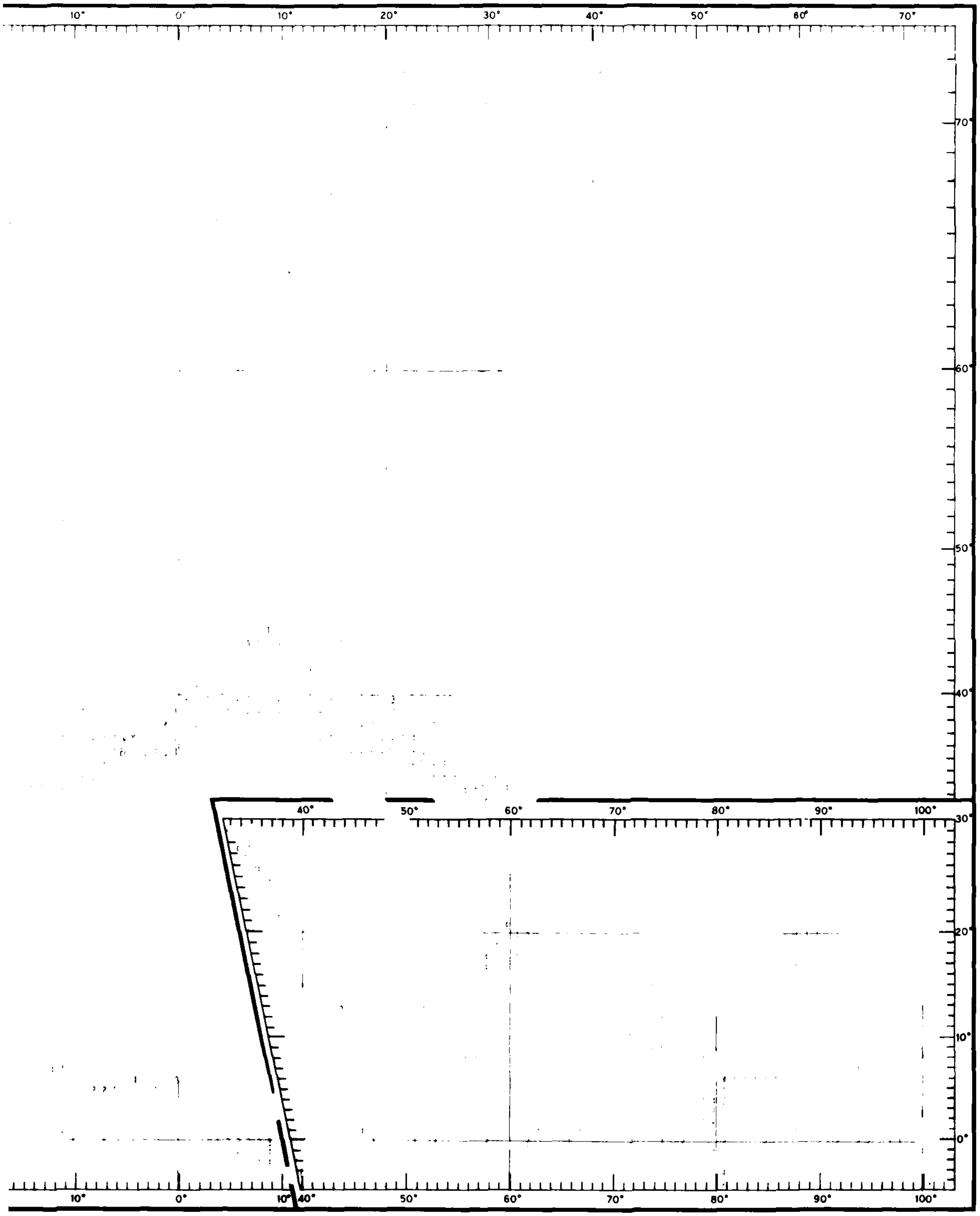


FIGURE 95. JULY DATA DISTRIBUTION OF TEMPERATURES AT 492 FT (150 M)



ION OF TEMPERATURES AT 492 FT (150 M)

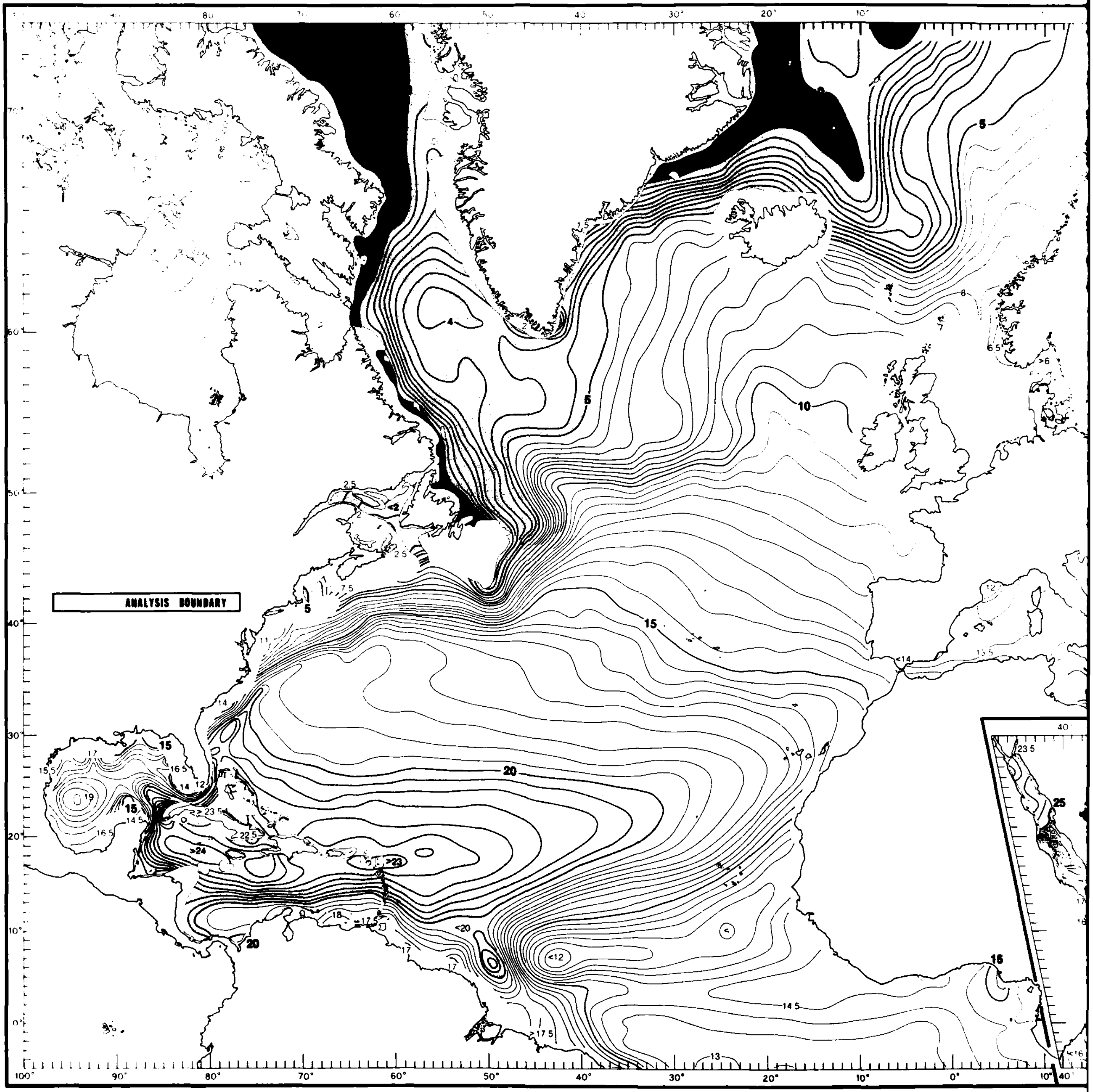
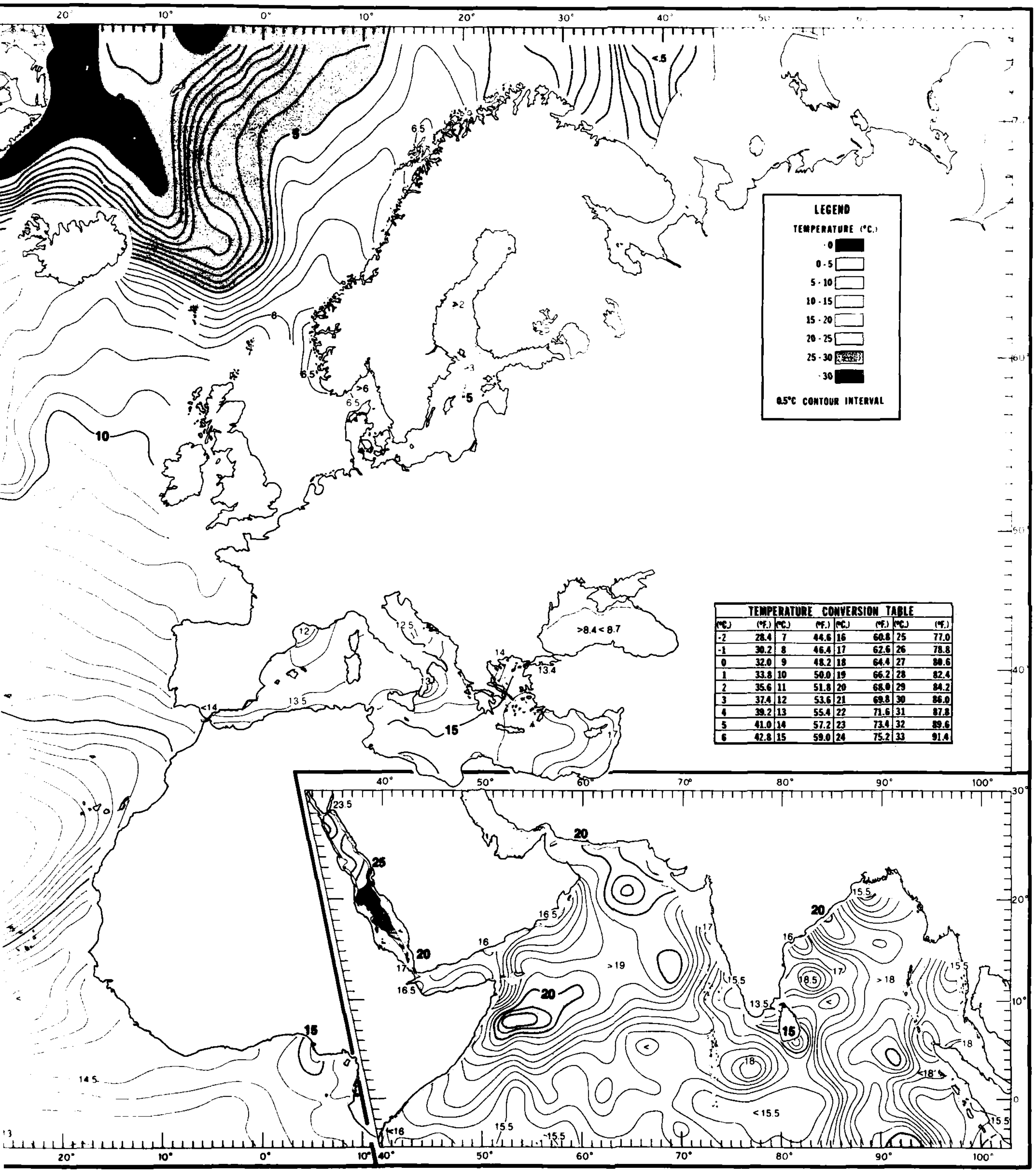


FIGURE 96. JULY MEAN TEMPERATURES AT 492 FT (150 M)



TEMPERATURE CONVERSION TABLE							
(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

JULY MEAN TEMPERATURES AT 492 FT (150 M)

12

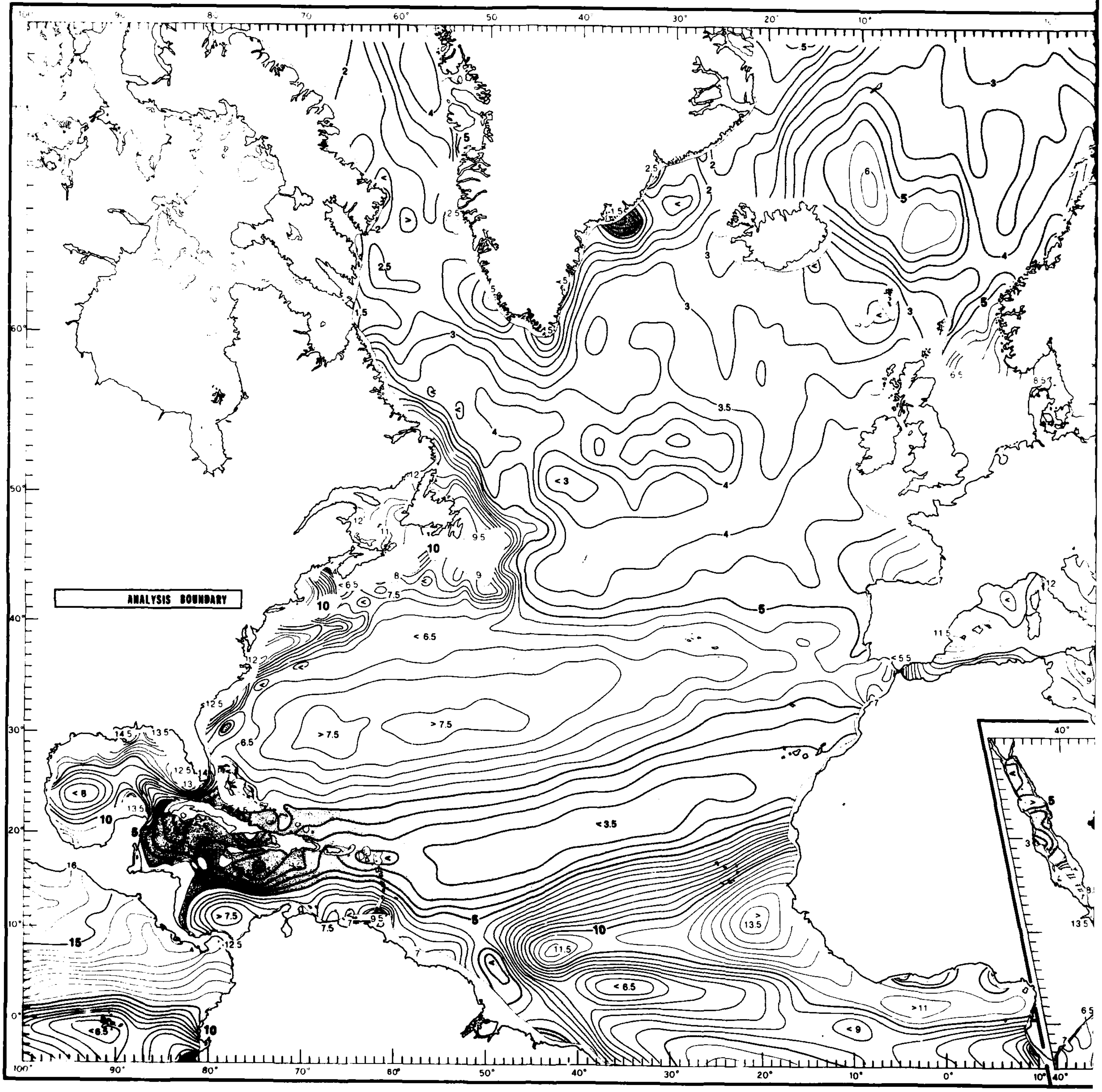
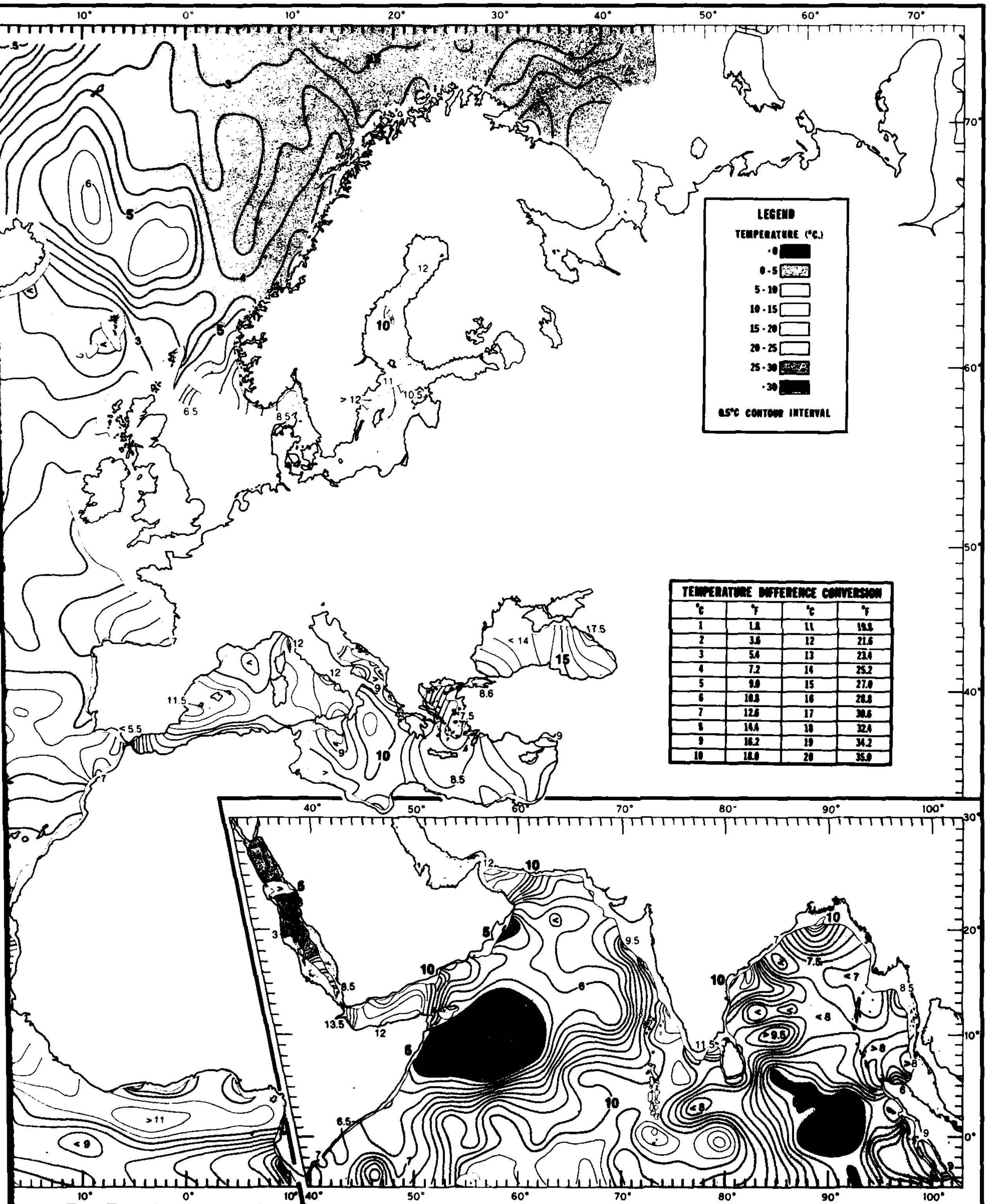


FIGURE 97. JULY TEMPERATURE DIFFERENCE BETWEEN THE SURFACE AND 400 FT (T



TEMPERATURE DIFFERENCE CONVERSION			
°C	°F	°C	°F
1	1.8	11	19.8
2	3.6	12	21.6
3	5.4	13	23.4
4	7.2	14	25.2
5	9.0	15	27.0
6	10.8	16	28.8
7	12.6	17	30.6
8	14.4	18	32.4
9	16.2	19	34.2
10	18.0	20	35.0

NCE BETWEEN THE SURFACE AND 400 FT (T_0-T_{400})

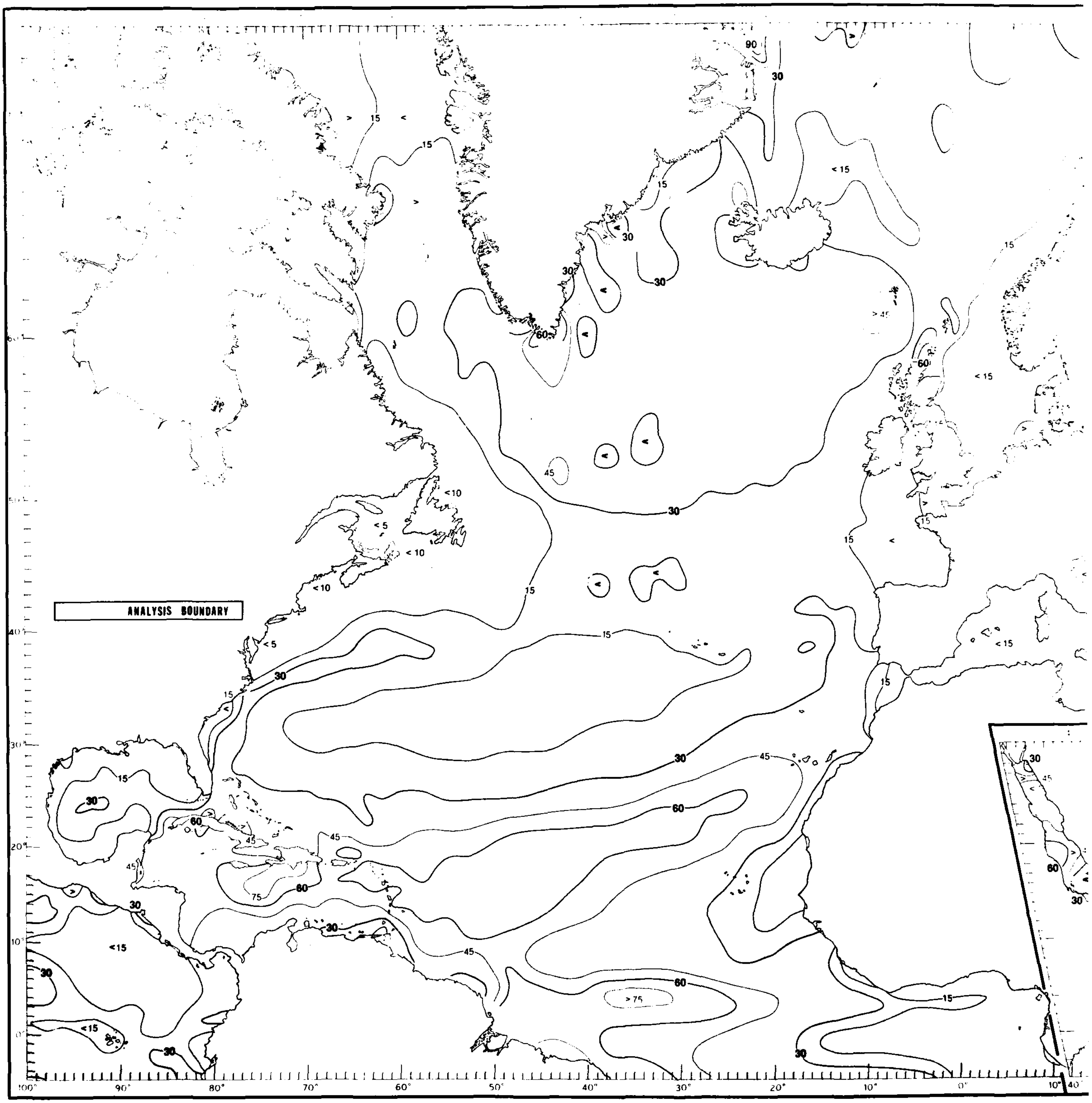
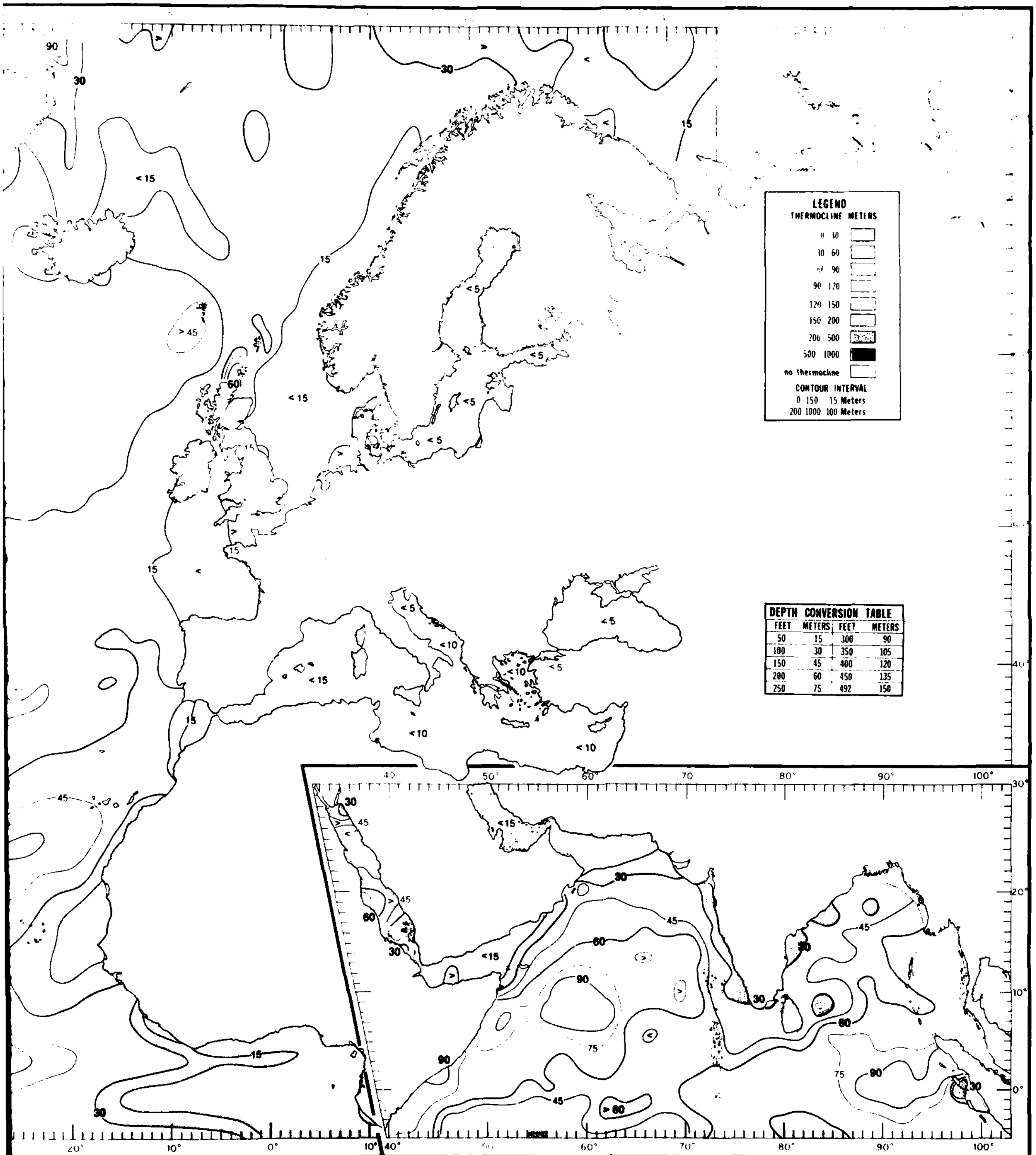


FIGURE 98. JULY MEAN DEPTHS TO THE TOP OF THE THERMOCLINE



DEPTH CONVERSION TABLE			
FEET	METERS	FEET	METERS
50	15	300	90
100	30	350	105
150	45	400	120
200	60	450	135
250	75	492	150

MEAN DEPTHS TO THE TOP OF THE THERMOCLINE

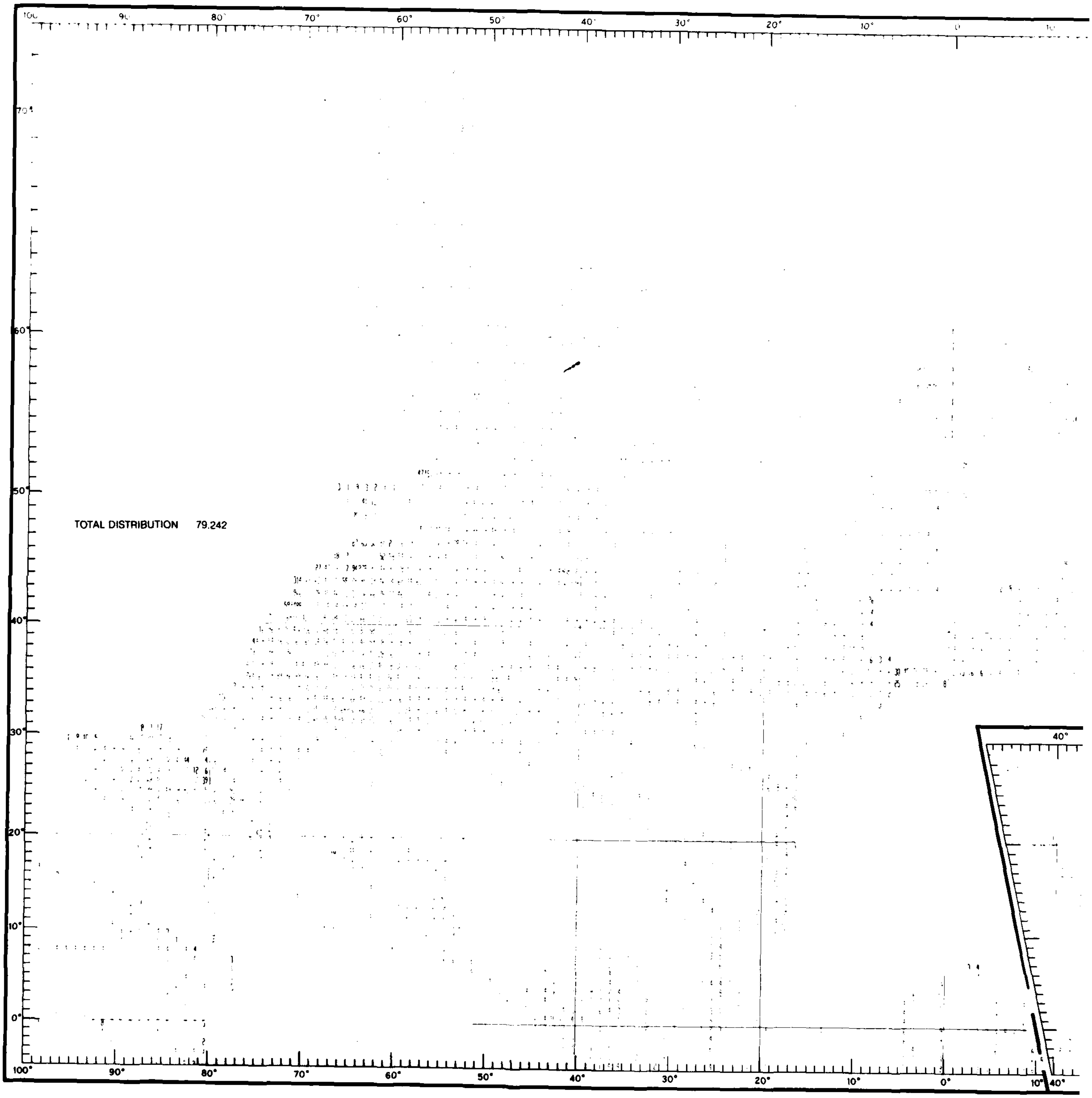
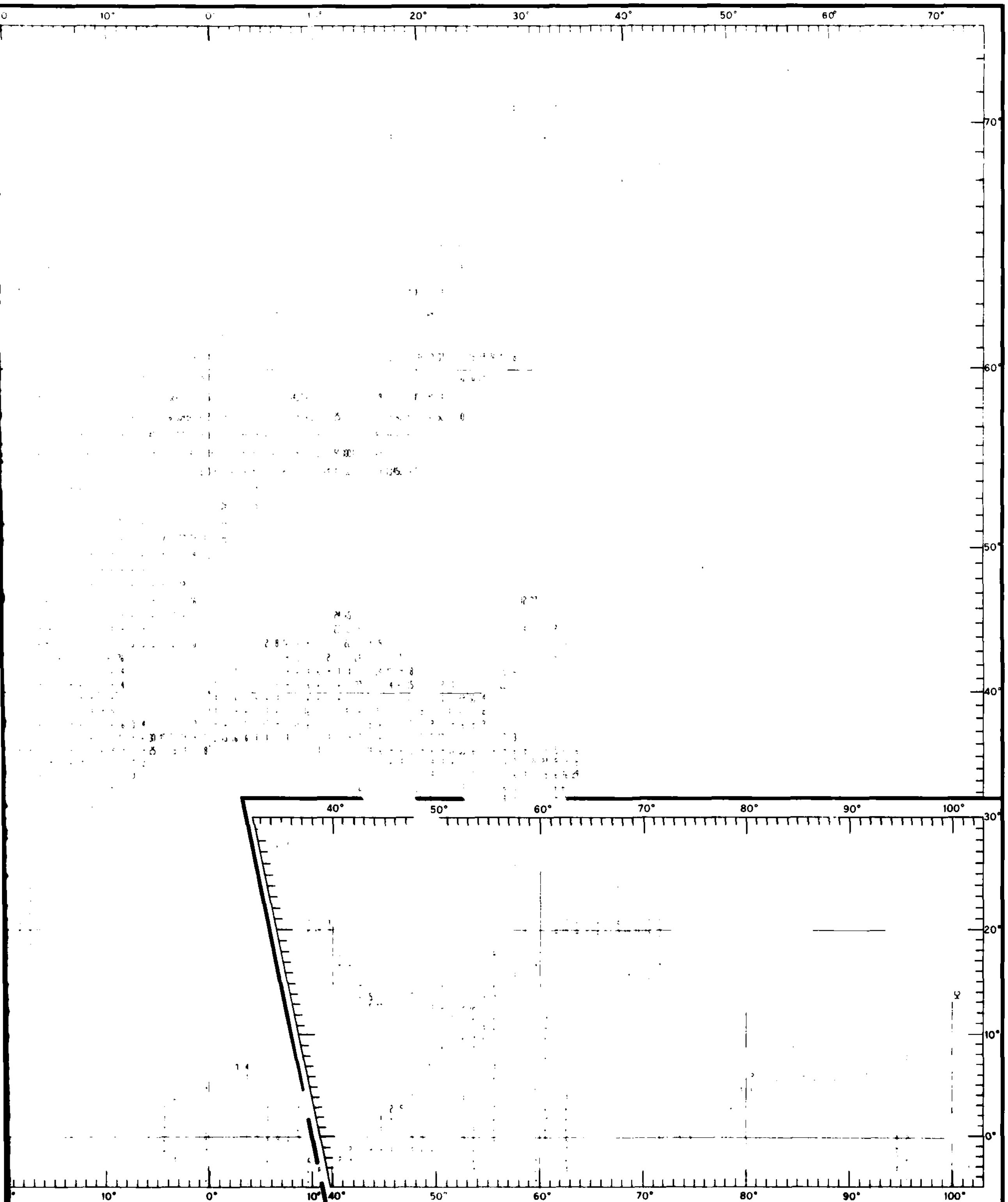


FIGURE 99. AUGUST DATA DISTRIBUTION OF TEMPERATURES AT THE SURFAC



RIBUTION OF TEMPERATURES AT THE SURFACE

1 2

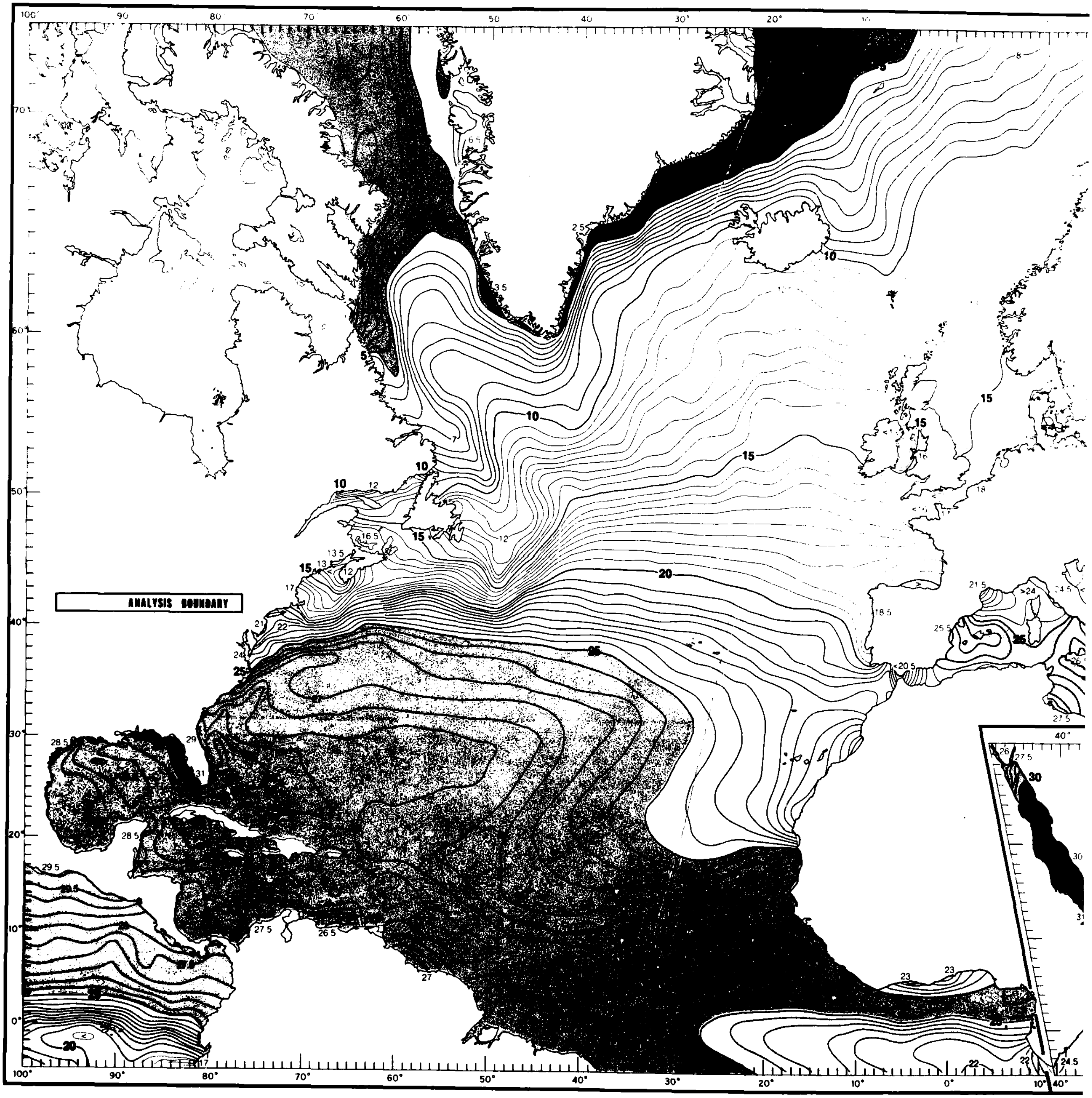
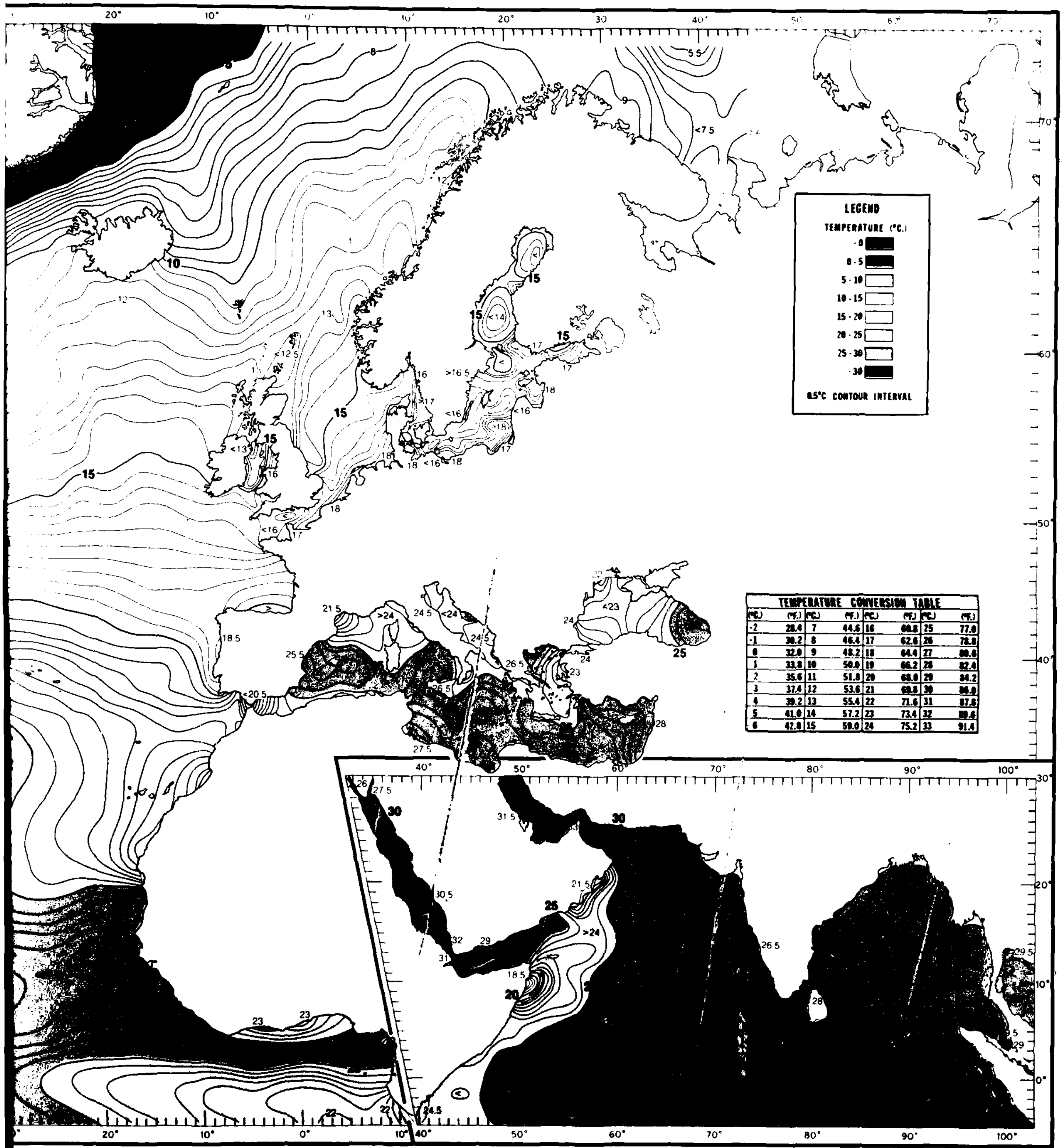


FIGURE 100. AUGUST MEAN TEMPERATURES AT THE SURFACE



TEMPERATURE CONVERSION TABLE

(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

E 100. AUGUST MEAN TEMPERATURES AT THE SURFACE

2

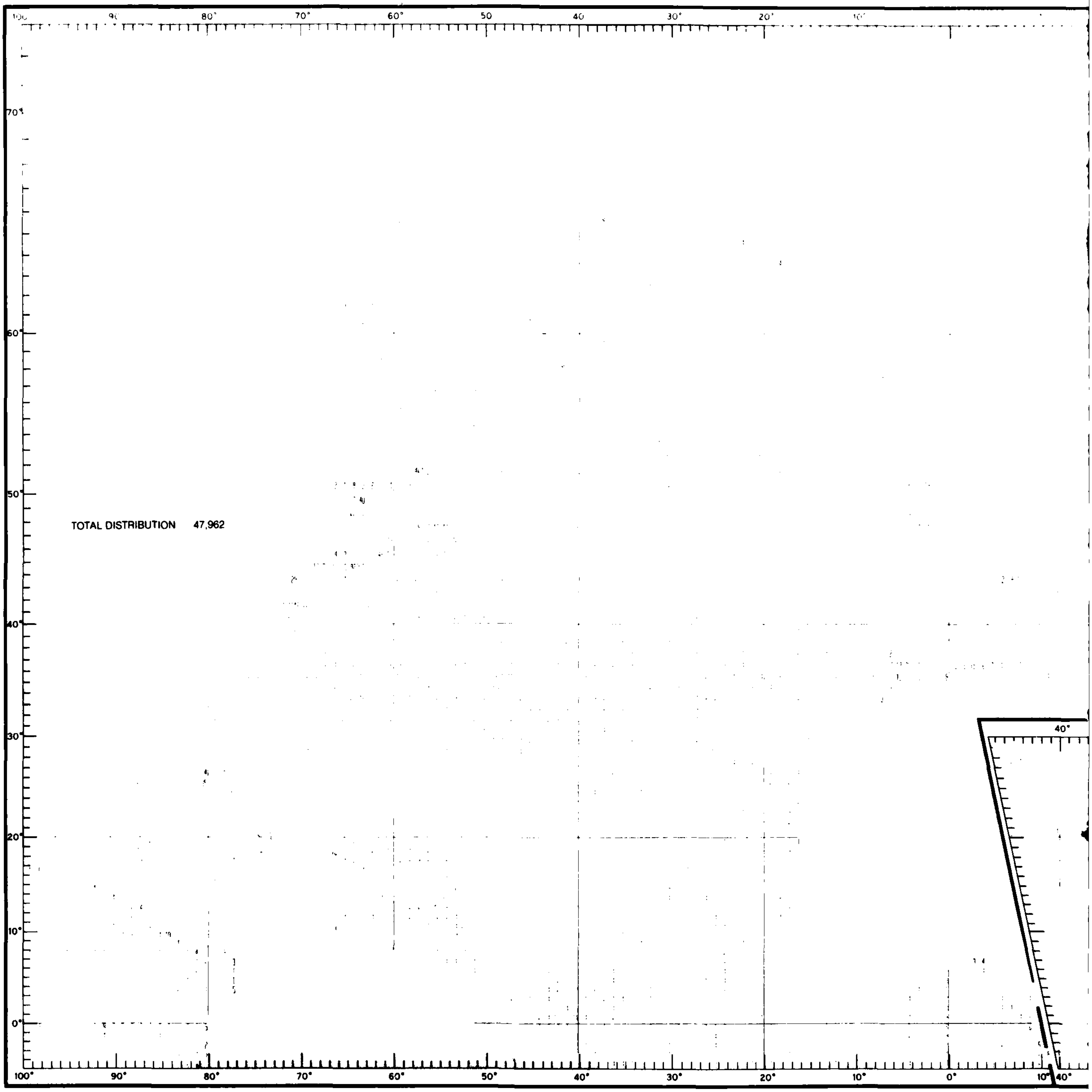
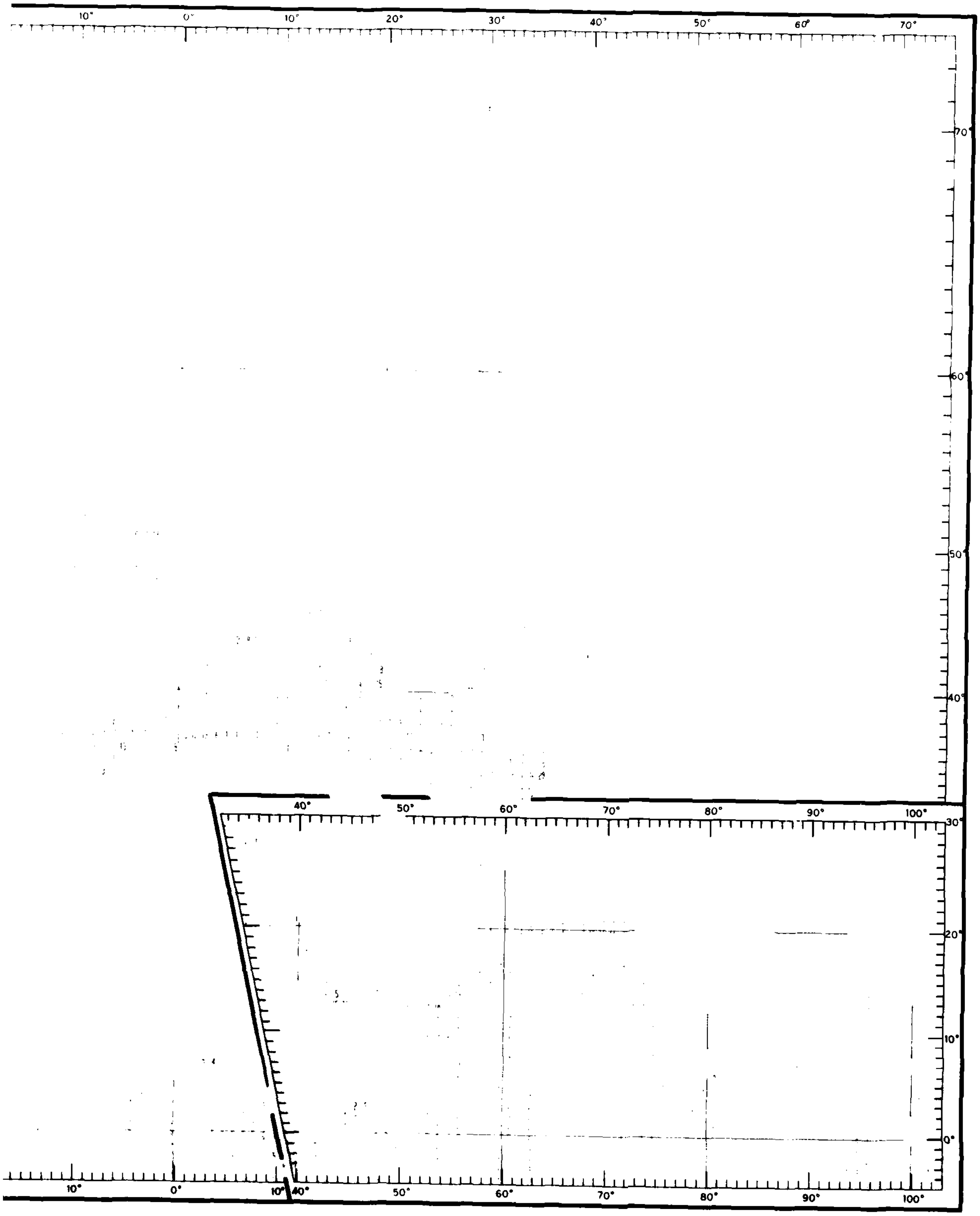


FIGURE 101. AUGUST DATA DISTRIBUTION OF TEMPERATURES AT 100 FT (30 M



UTION OF TEMPERATURES AT 100 FT (30 M)

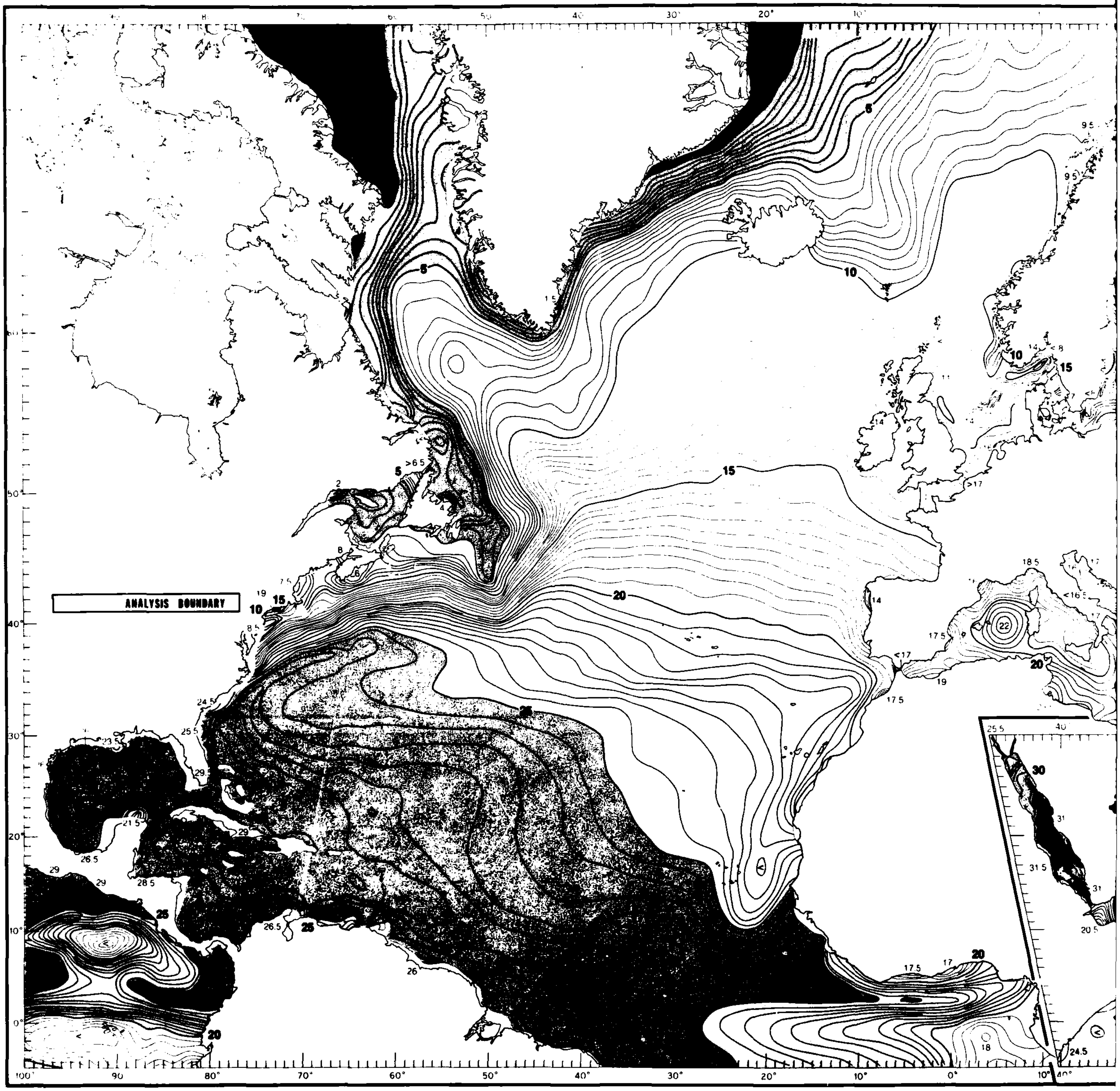
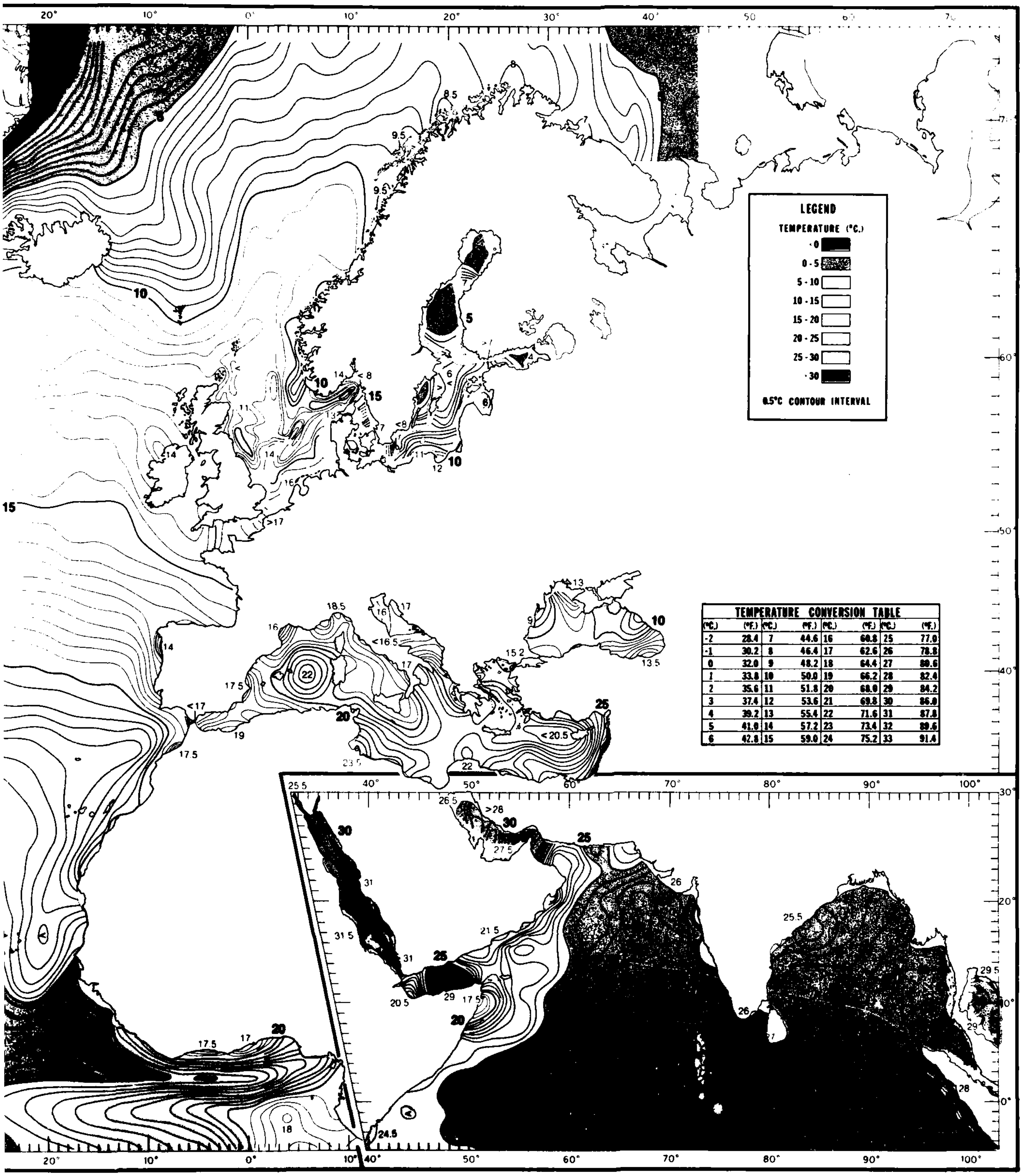


FIGURE 102. AUGUST MEAN TEMPERATURES AT 100 FT (30 M)



TEMPERATURE CONVERSION TABLE

(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

ST MEAN TEMPERATURES AT 100 FT (30 M)

12

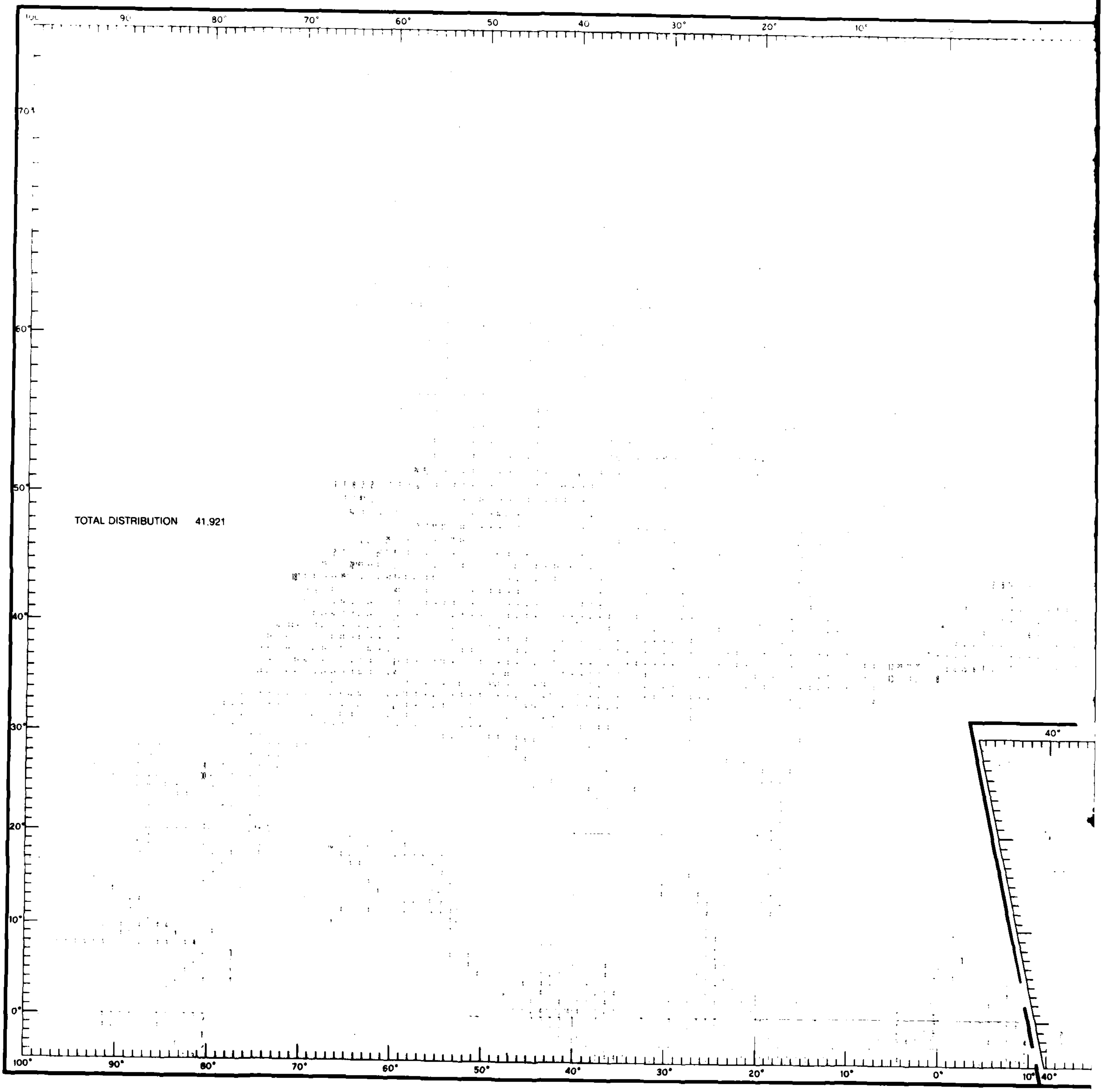
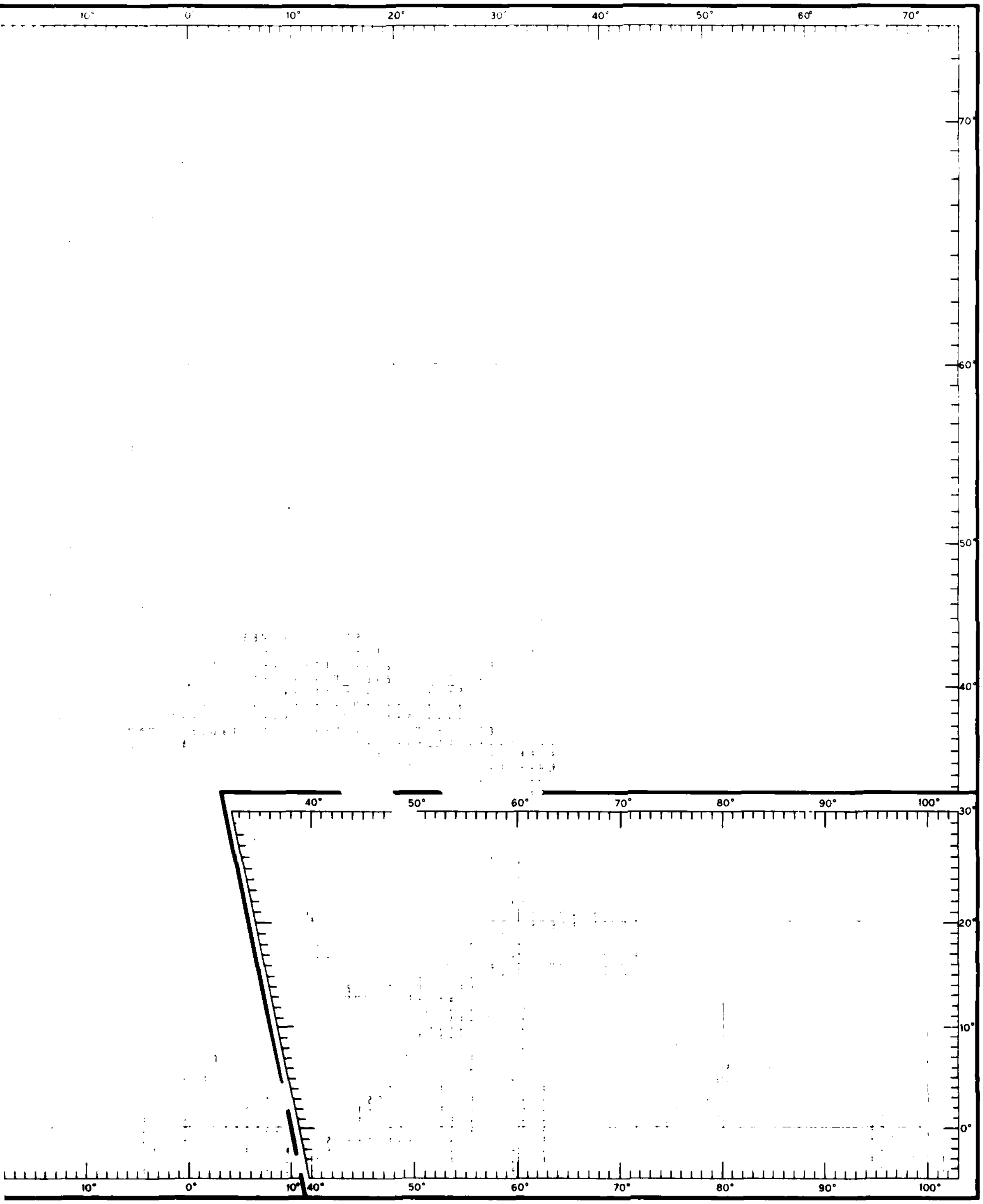


FIGURE 103. AUGUST DATA DISTRIBUTION OF TEMPERATURES AT 200 FT (60 M)



IBUTION OF TEMPERATURES AT 200 FT (60 M)

2

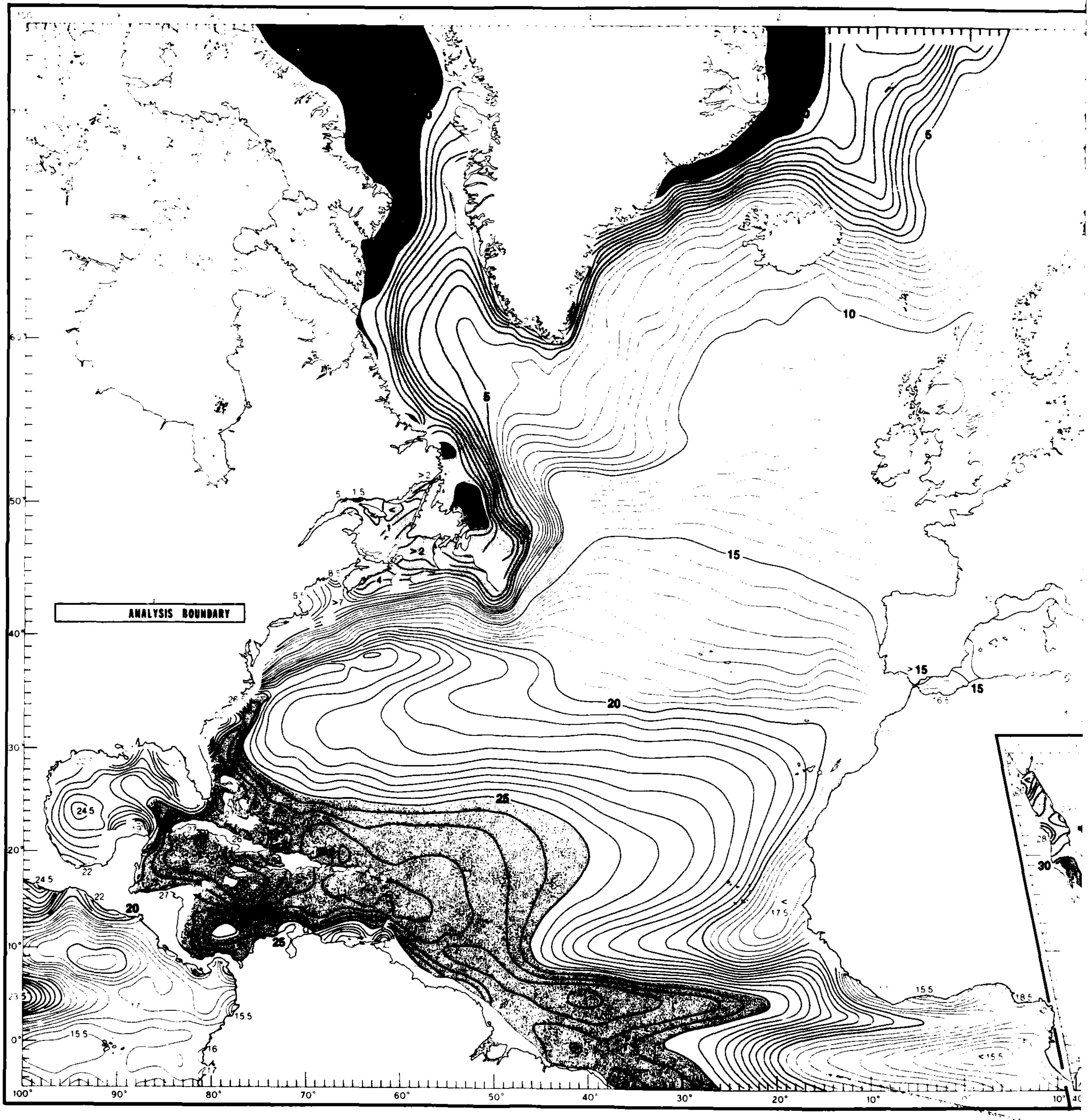
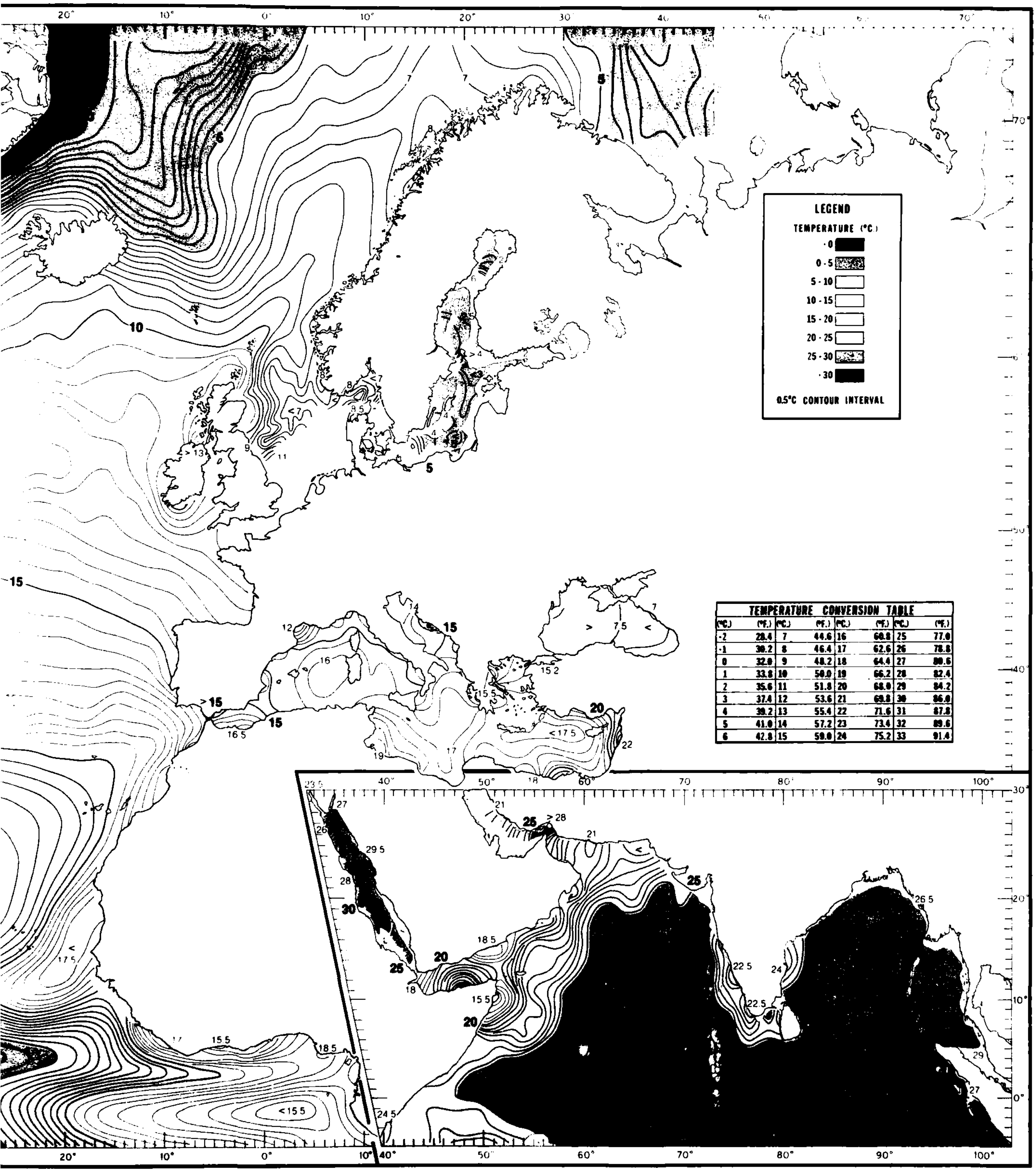


FIGURE 104. AUGUST MEAN TEMPERATURES AT 200 FT (60 M)



TEMPERATURE CONVERSION TABLE

(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

GUST MEAN TEMPERATURES AT 200 FT (60 M)

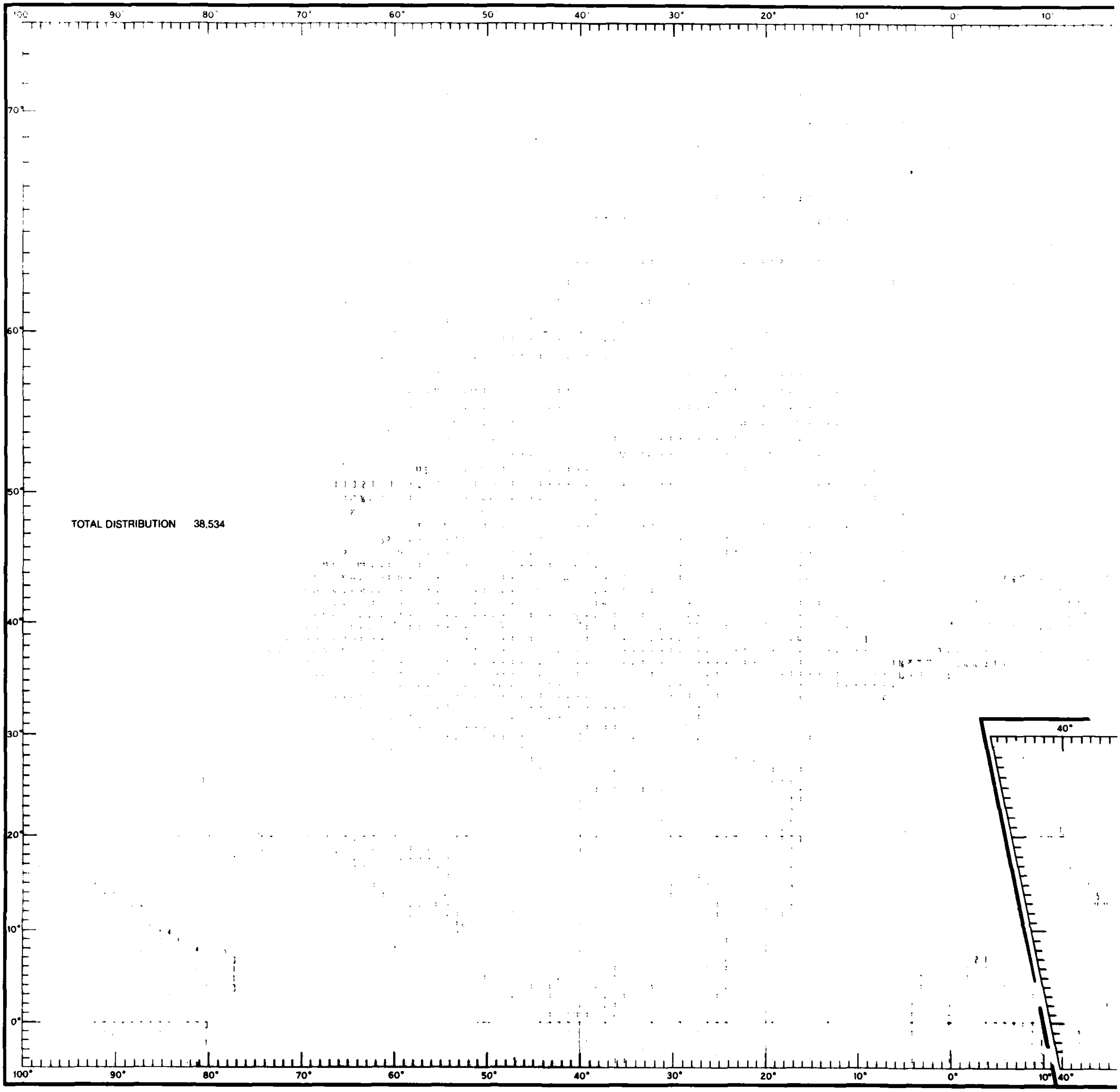
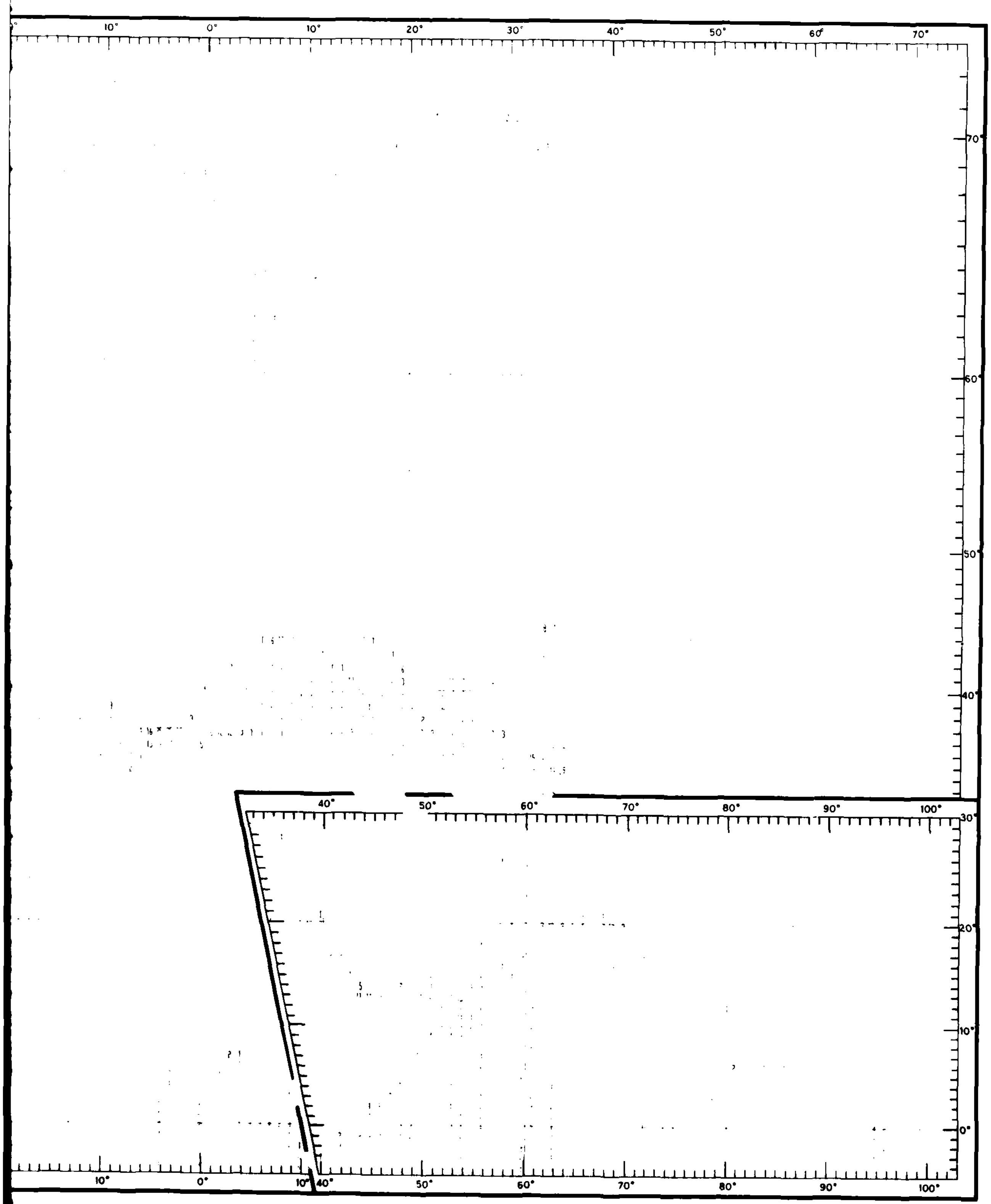


FIGURE 105. AUGUST DATA DISTRIBUTION OF TEMPERATURES AT 300 FT (90 M)



RIBUTION OF TEMPERATURES AT 300 FT (90 M)

1 2

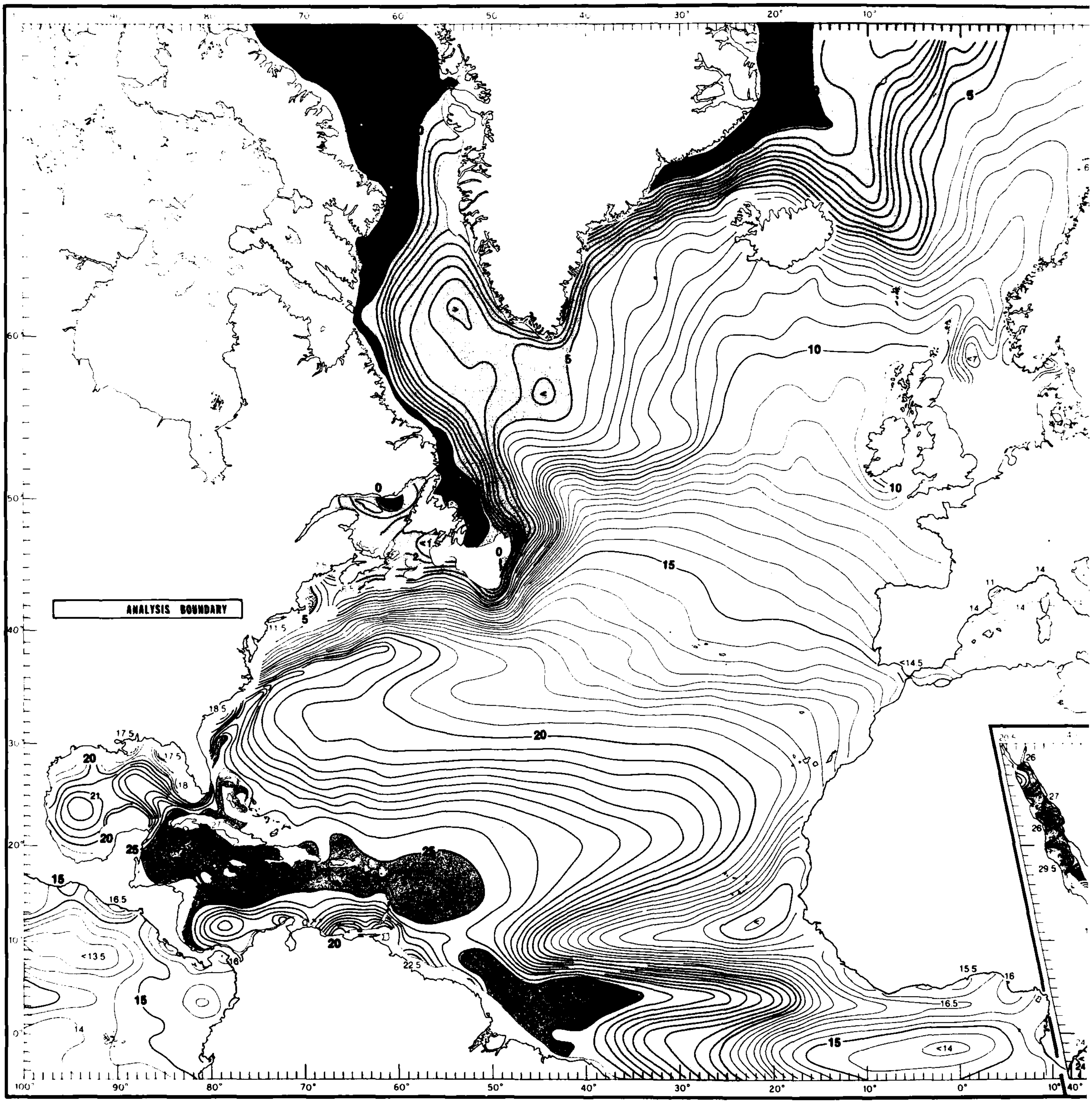
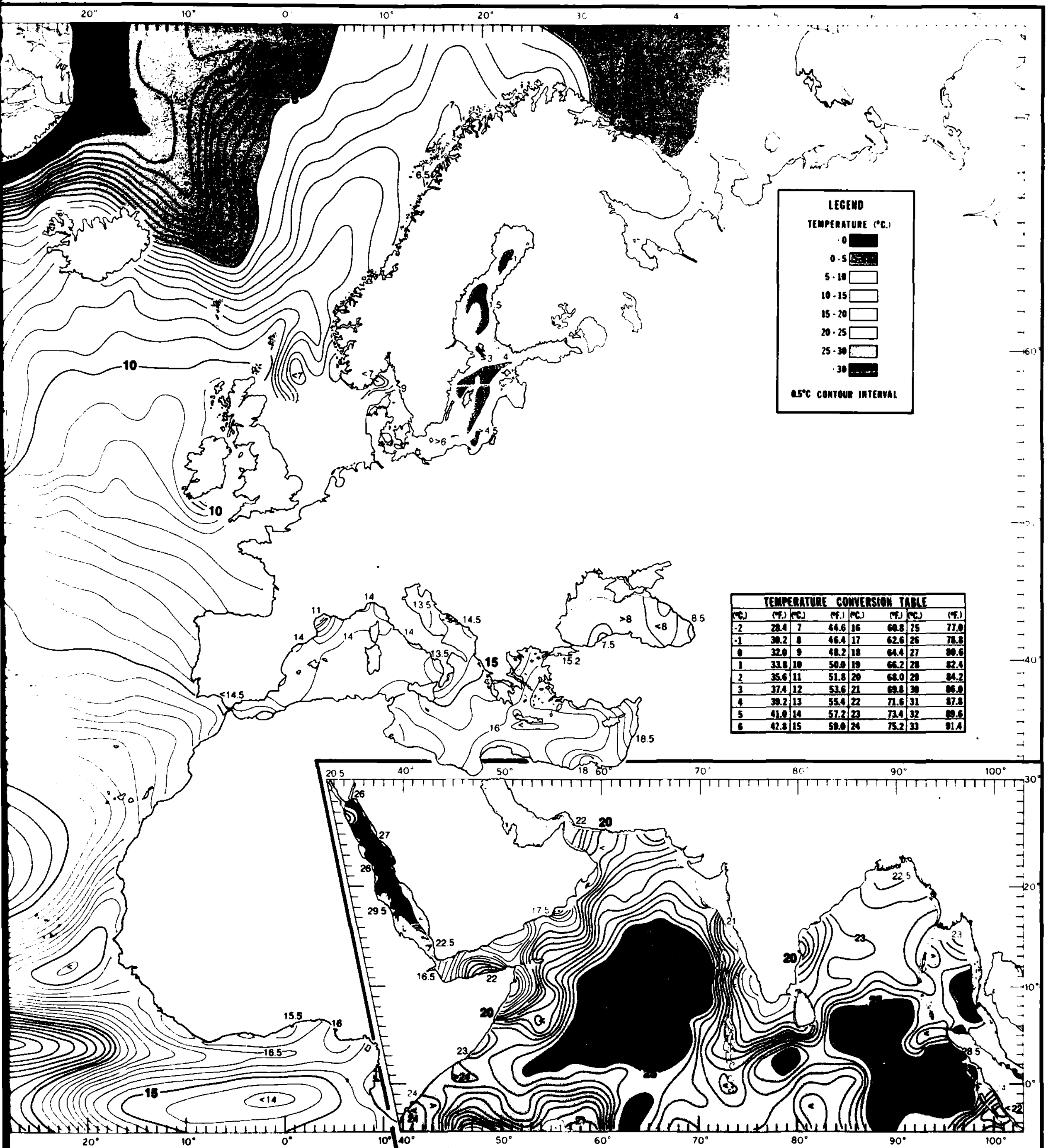


FIGURE 106. AUGUST MEAN TEMPERATURES AT 300 FT (90 M)



TEMPERATURE CONVERSION TABLE							
(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

AUGUST MEAN TEMPERATURES AT 300 FT (90 M)

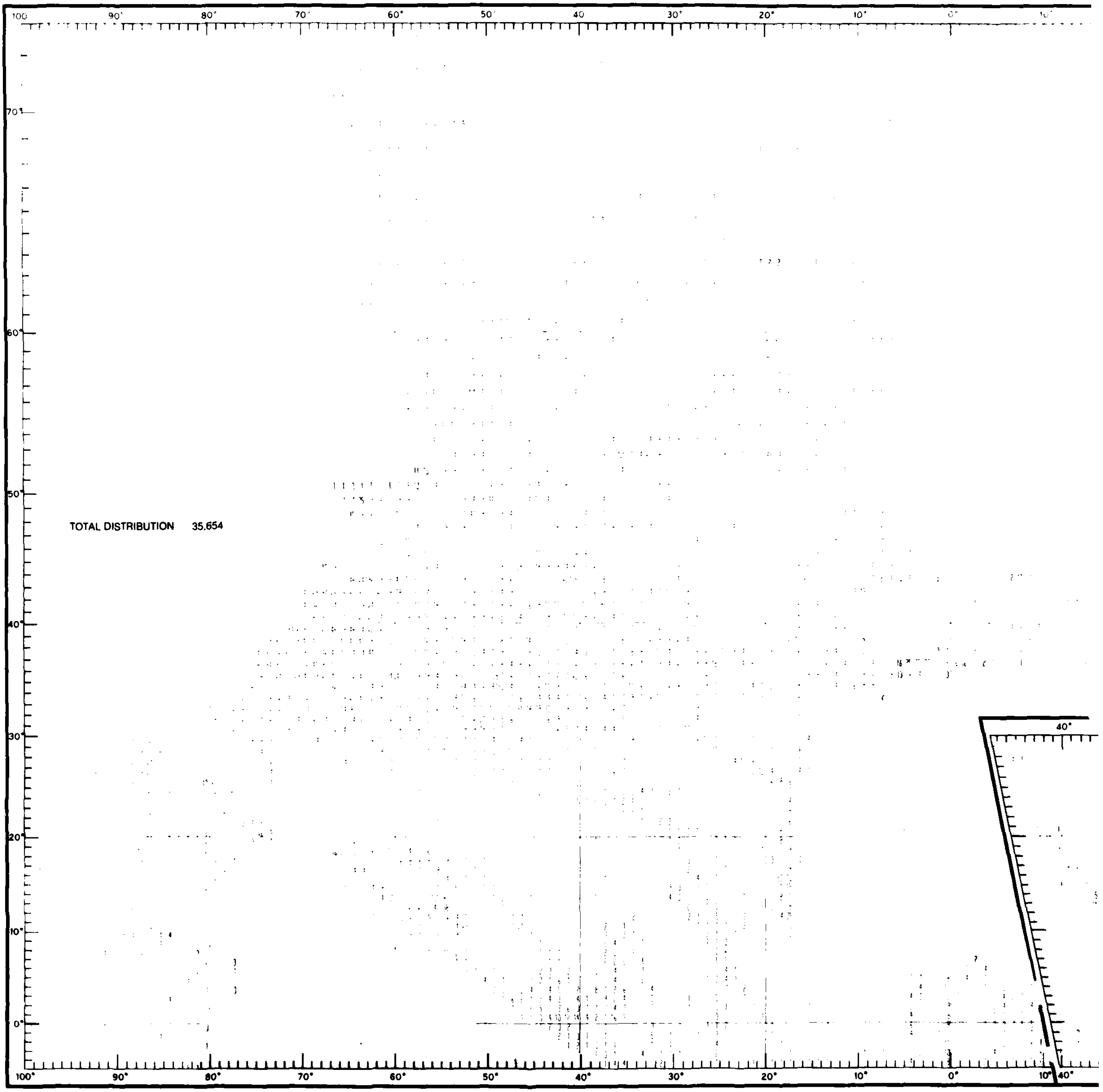
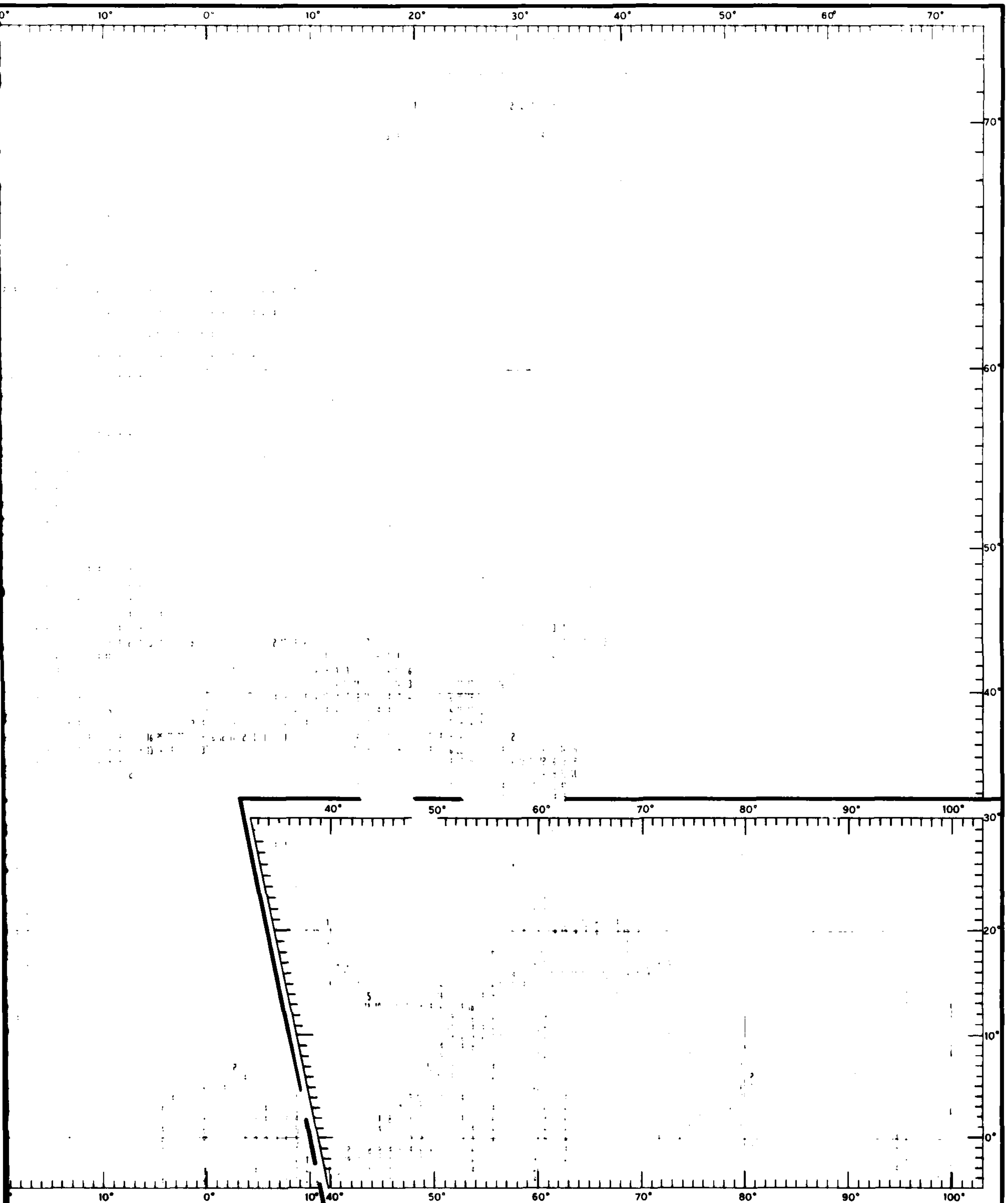


FIGURE 107. AUGUST DATA DISTRIBUTION OF TEMPERATURES AT 400 FT (120 M)



RIBUTION OF TEMPERATURES AT 400 FT (120 M)

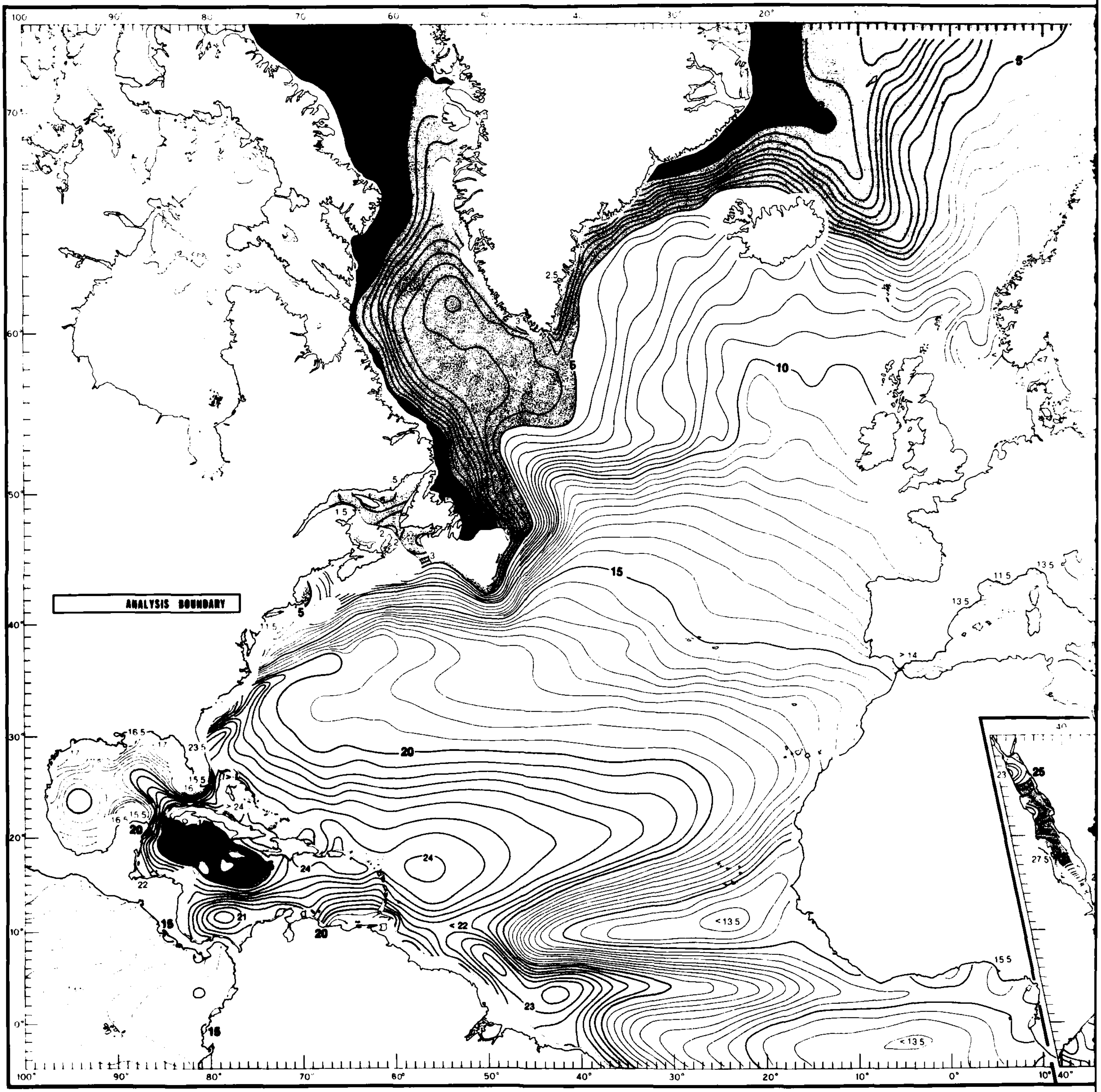
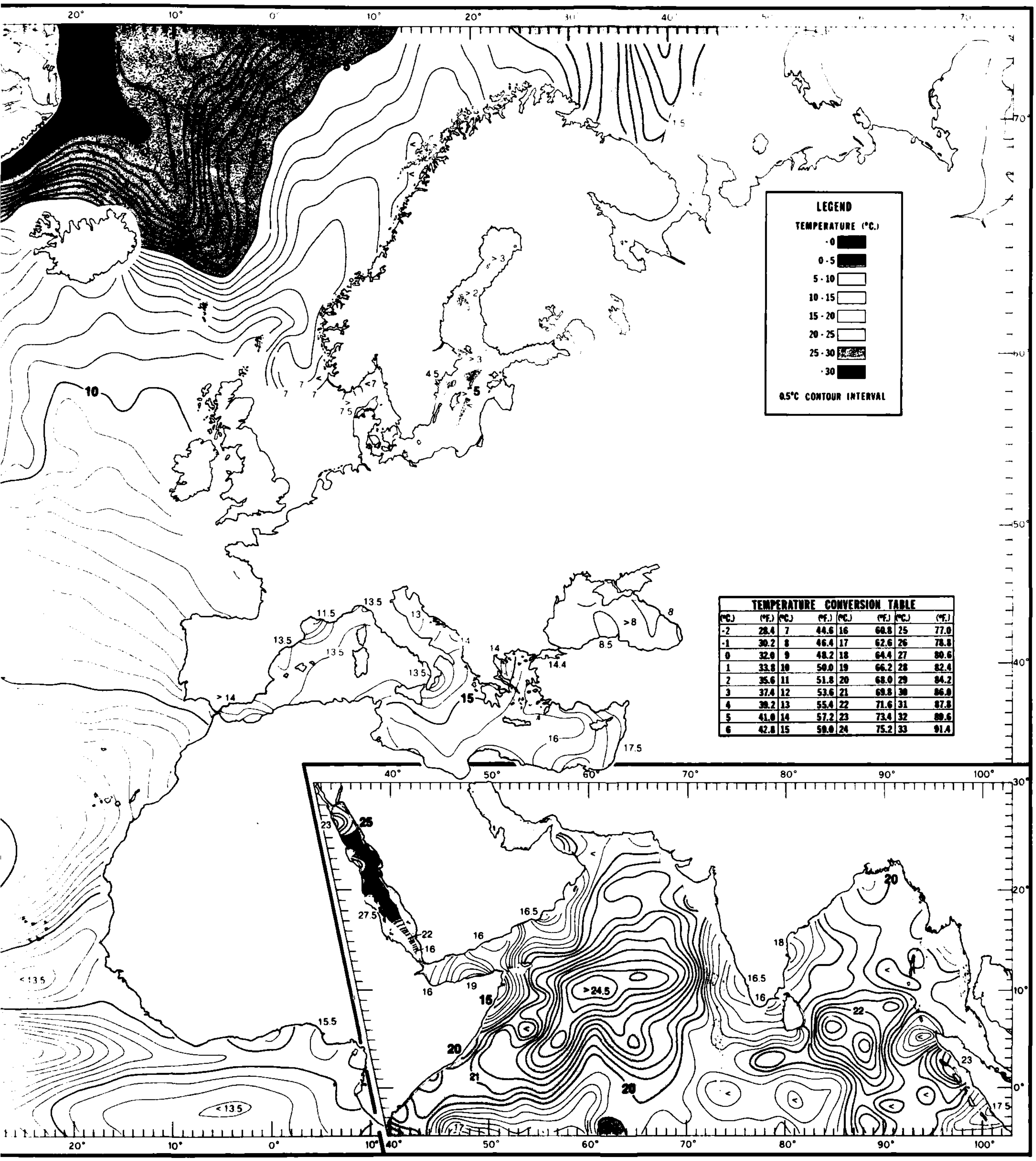


FIGURE 108. AUGUST MEAN TEMPERATURES AT 400 FT (120 M)



TEMPERATURE CONVERSION TABLE

(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

AUGUST MEAN TEMPERATURES AT 400 FT (120 M)

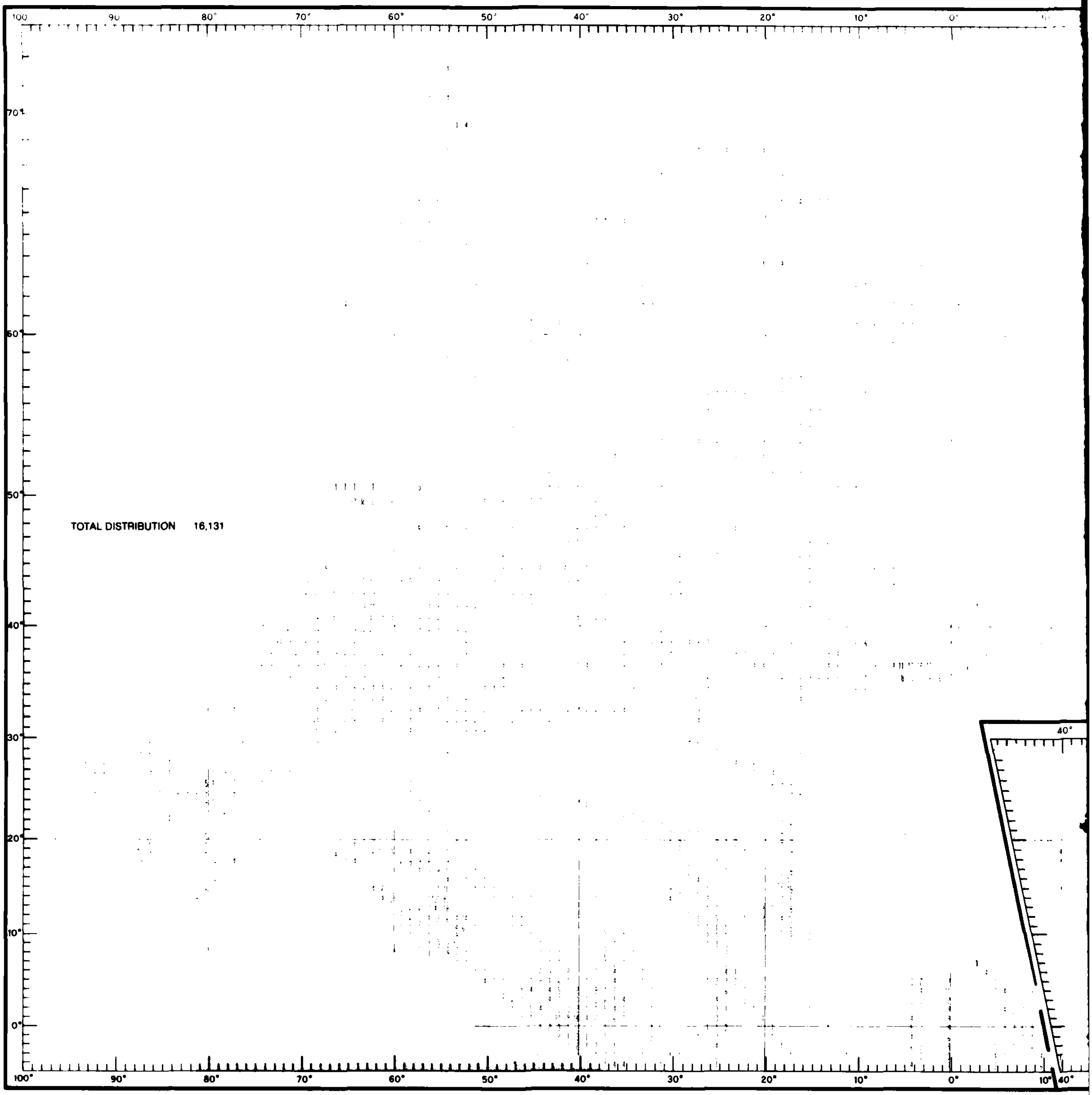
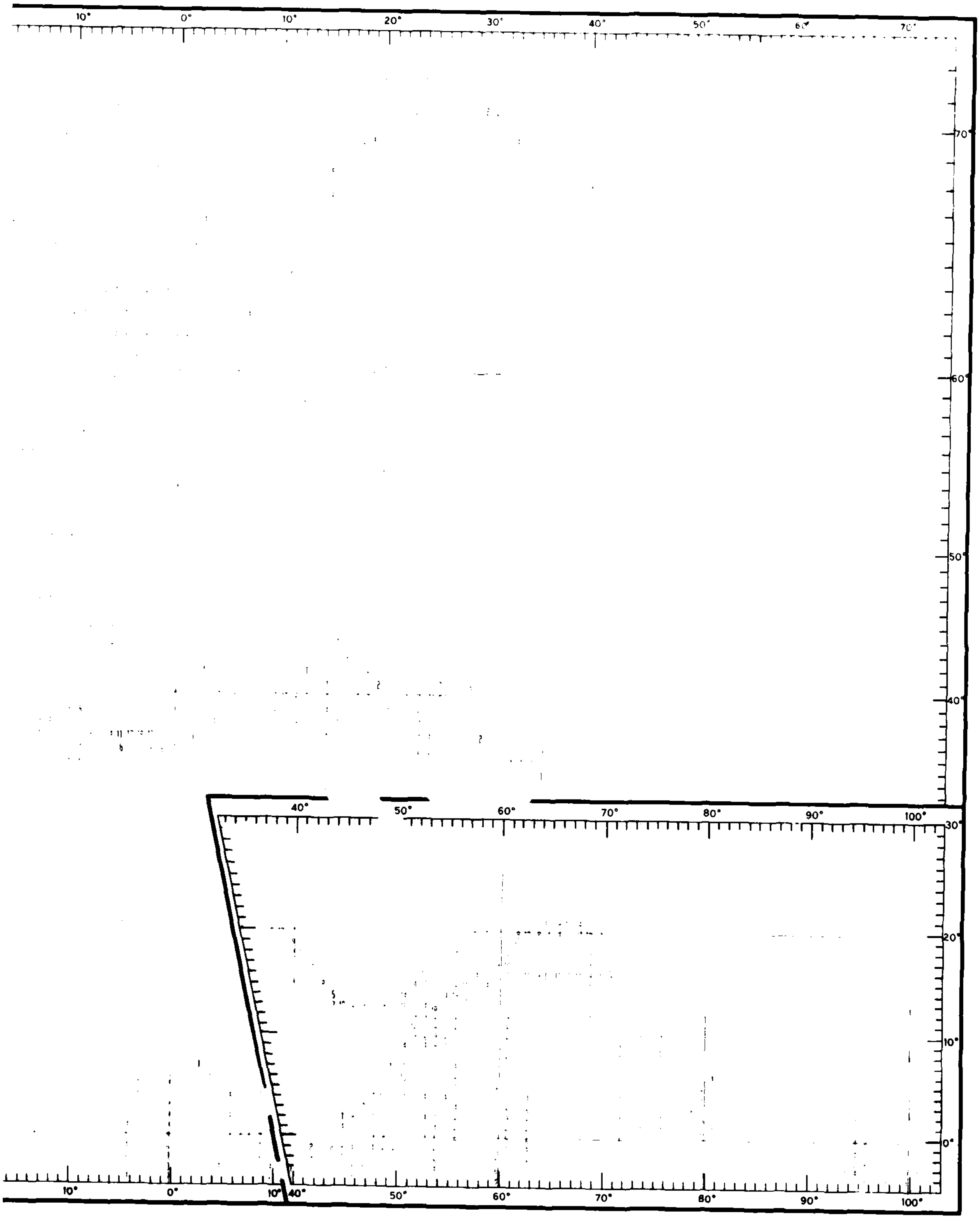


FIGURE 109. AUGUST DATA DISTRIBUTION OF TEMPERATURES AT 492 FT (150



JTION OF TEMPERATURES AT 492 FT (150 M)

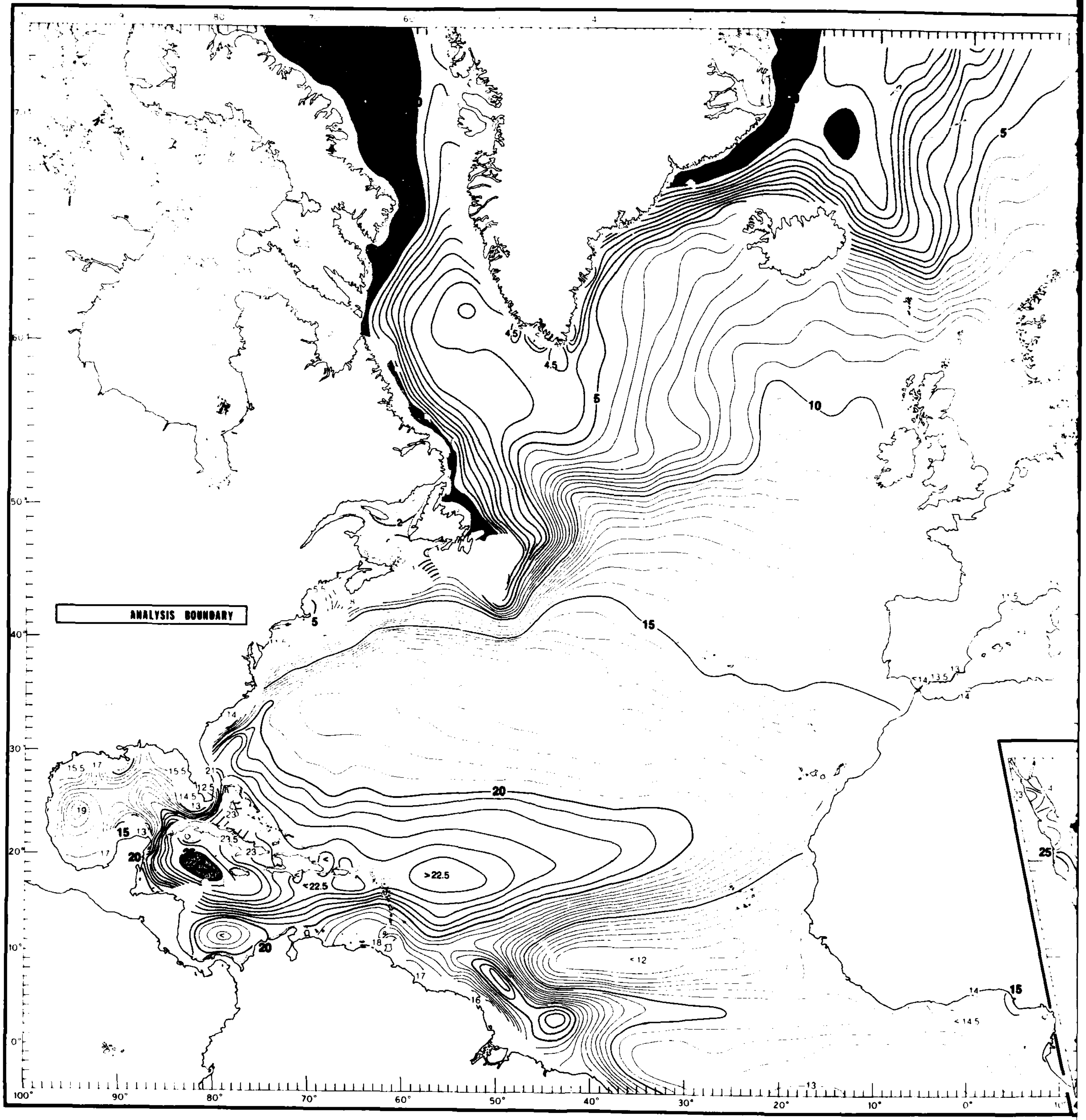
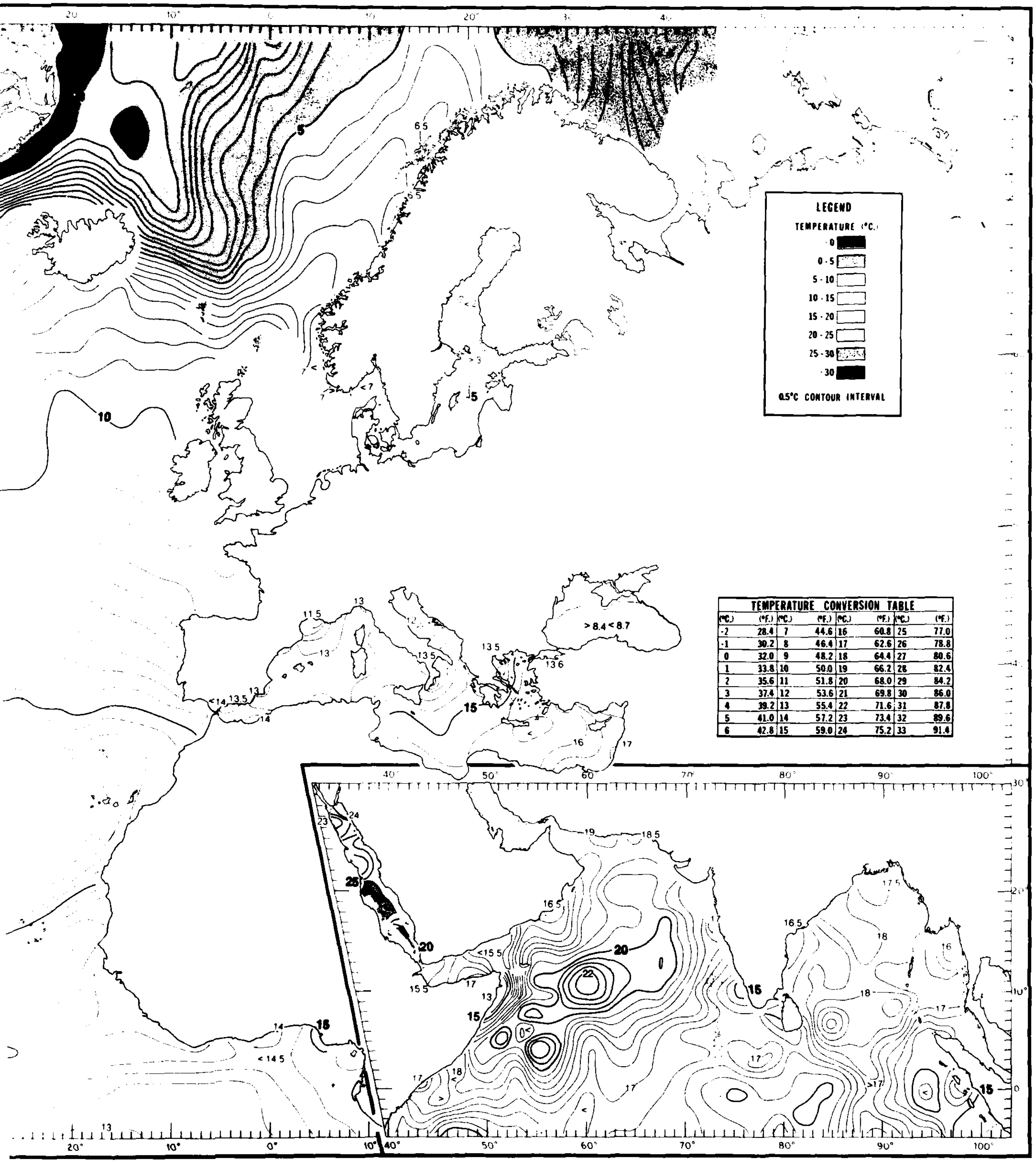


FIGURE 110. AUGUST MEAN TEMPERATURES AT 492 FT (150 M)



TEMPERATURE CONVERSION TABLE							
(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

ƷUST MEAN TEMPERATURES AT 492 FT (150 M)

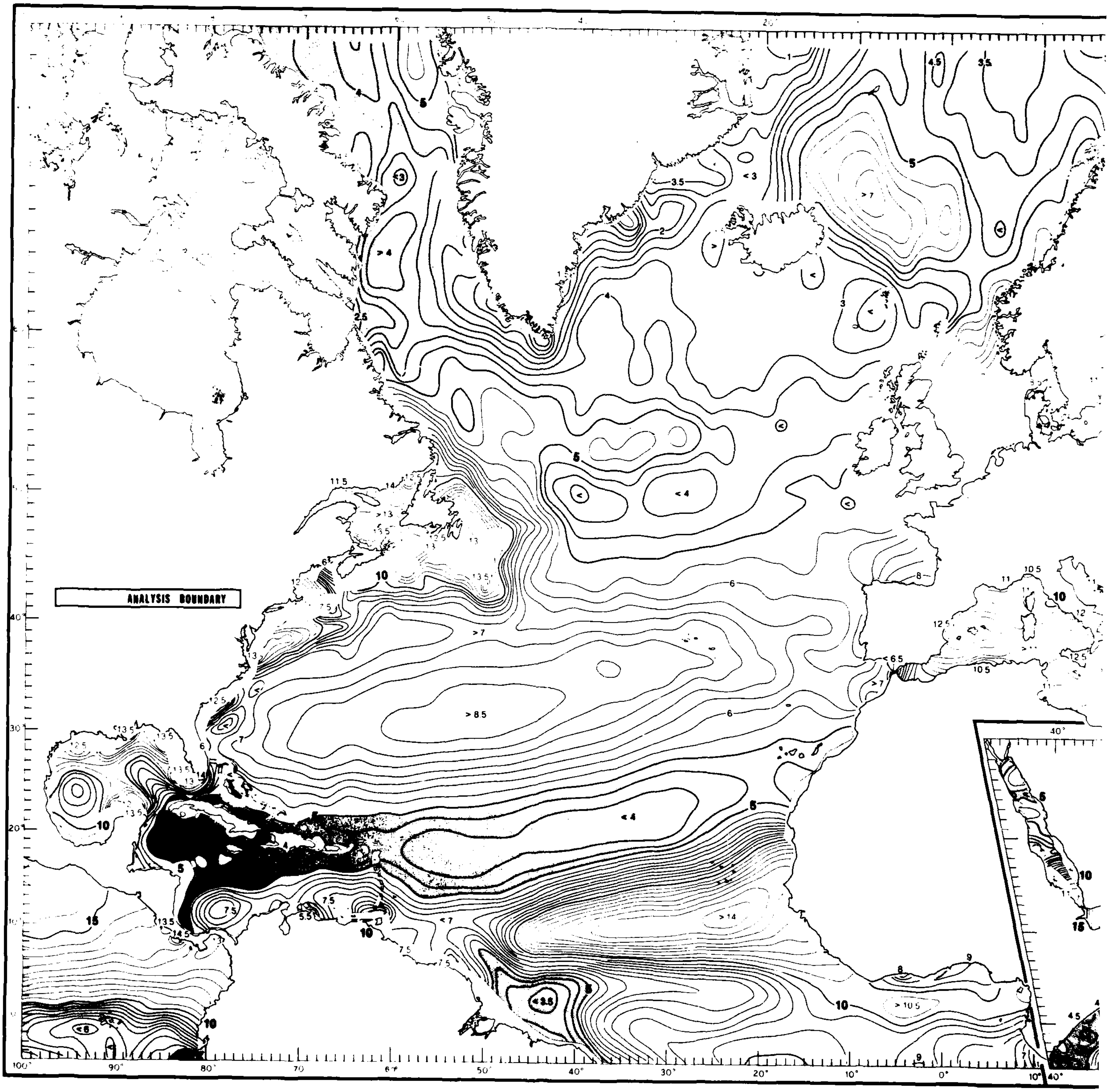
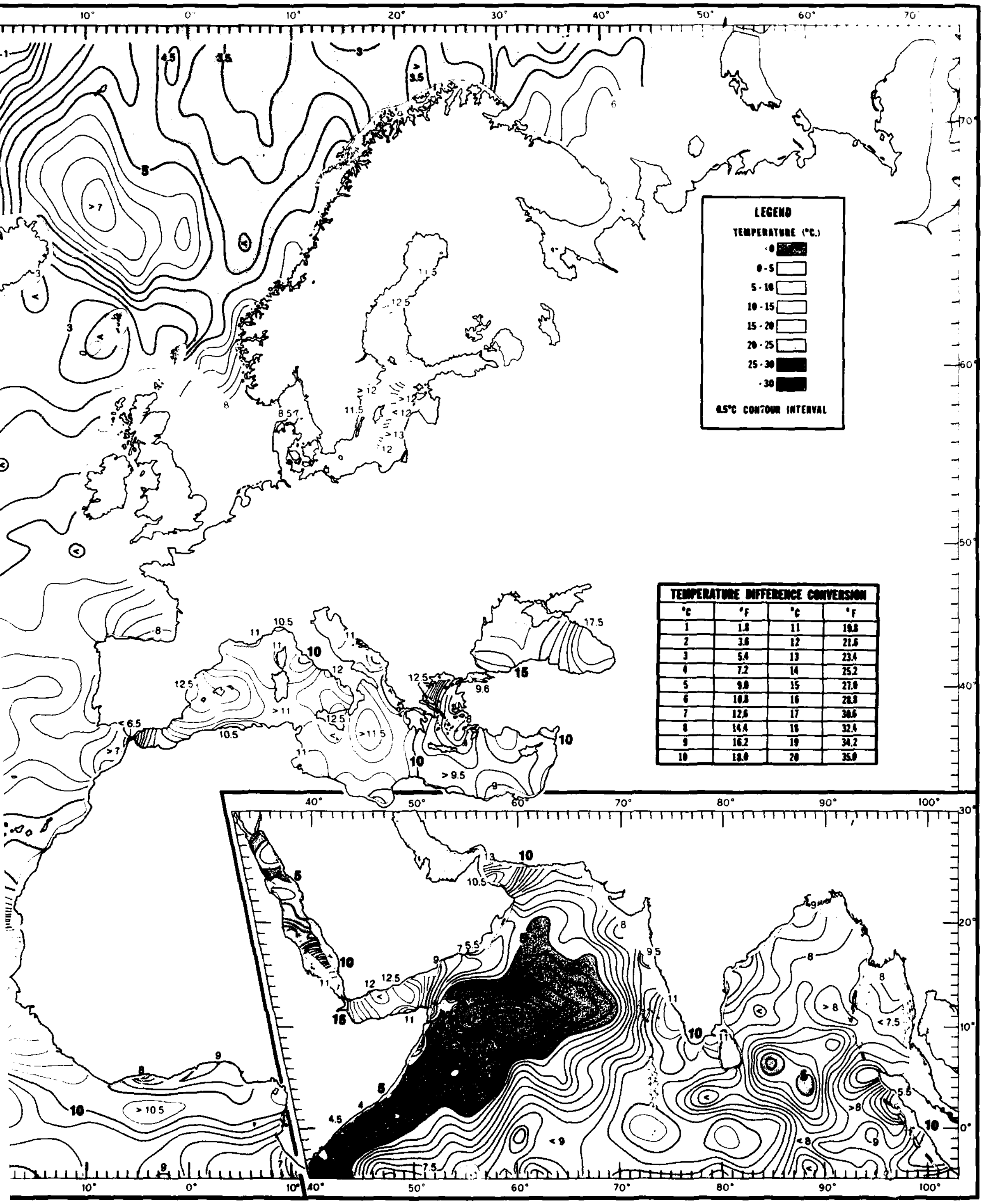


FIGURE 111. AUGUST TEMPERATURE DIFFERENCE BETWEEN THE SURFACE AND 400 FT (T



TEMPERATURE DIFFERENCE CONVERSION			
°C	°F	°C	°F
1	1.8	11	19.8
2	3.6	12	21.6
3	5.4	13	23.4
4	7.2	14	25.2
5	9.0	15	27.0
6	10.8	16	28.8
7	12.6	17	30.6
8	14.4	18	32.4
9	16.2	19	34.2
10	18.0	20	35.0

IENCE BETWEEN THE SURFACE AND 400 FT (T_0-T_{400})

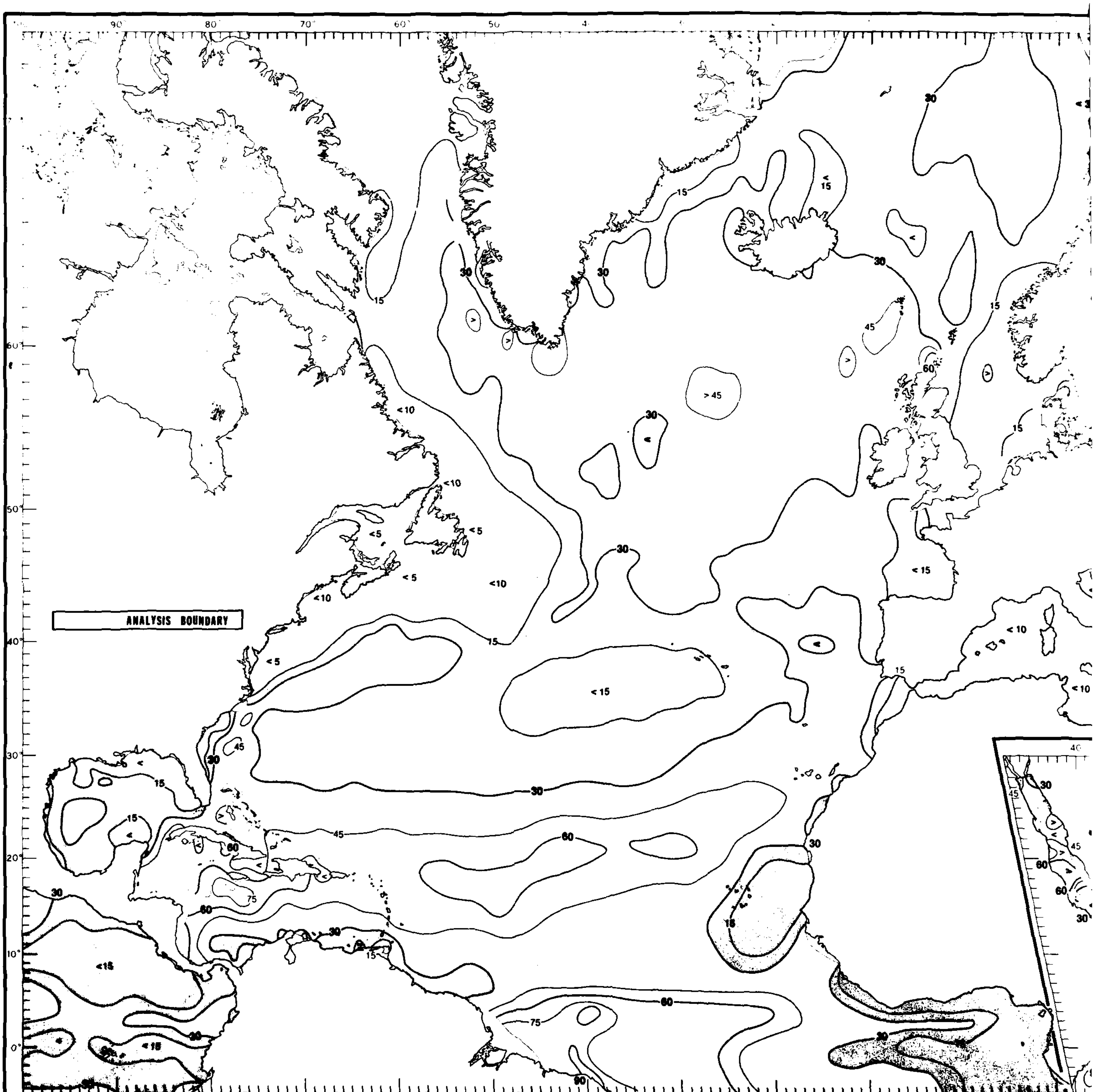
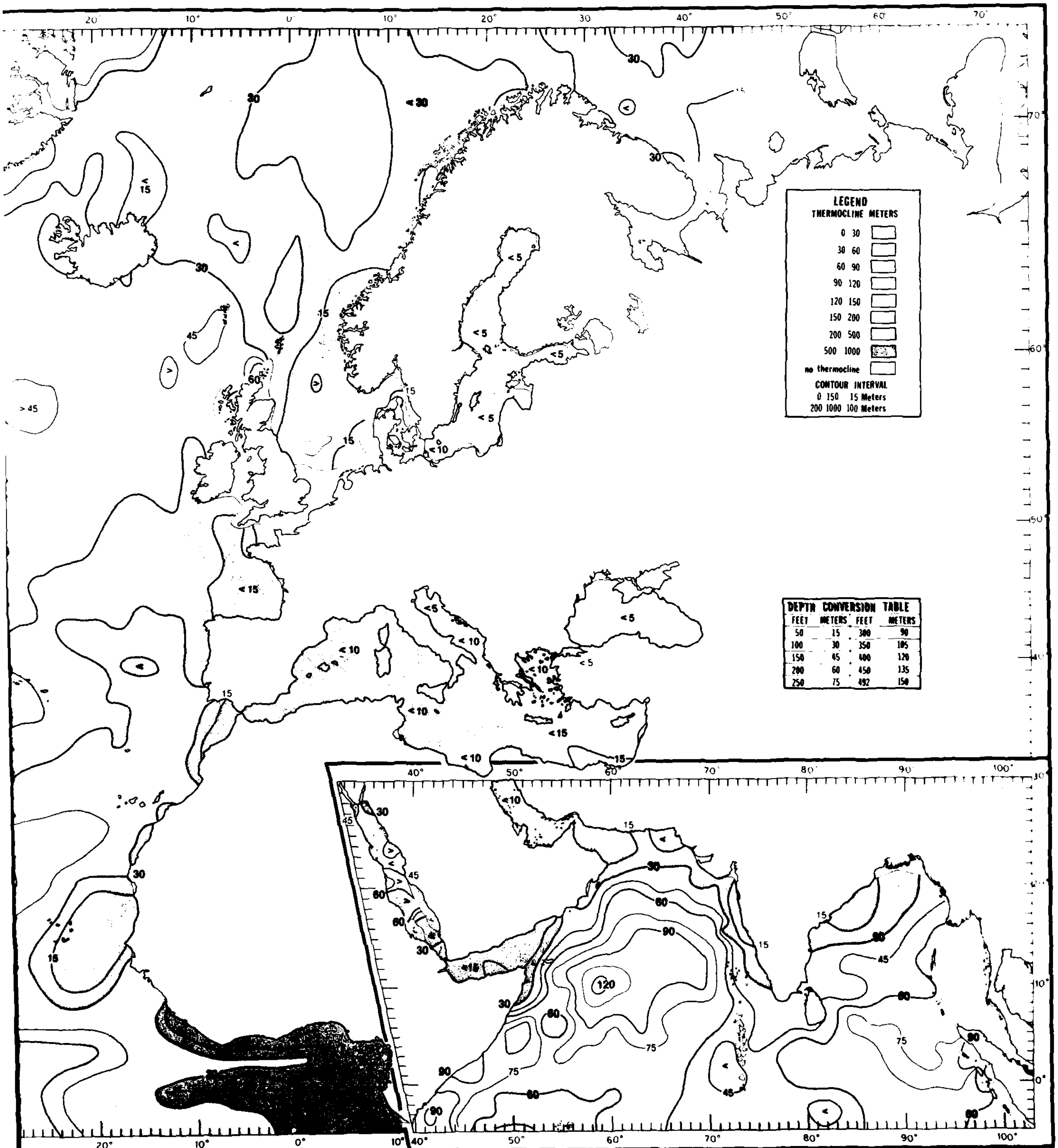


FIGURE 112. AUGUST MEAN DEPTHS TO THE TOP OF THE THERMOCLINE



MEAN DEPTHS TO THE TOP OF THE THERMOCLINE

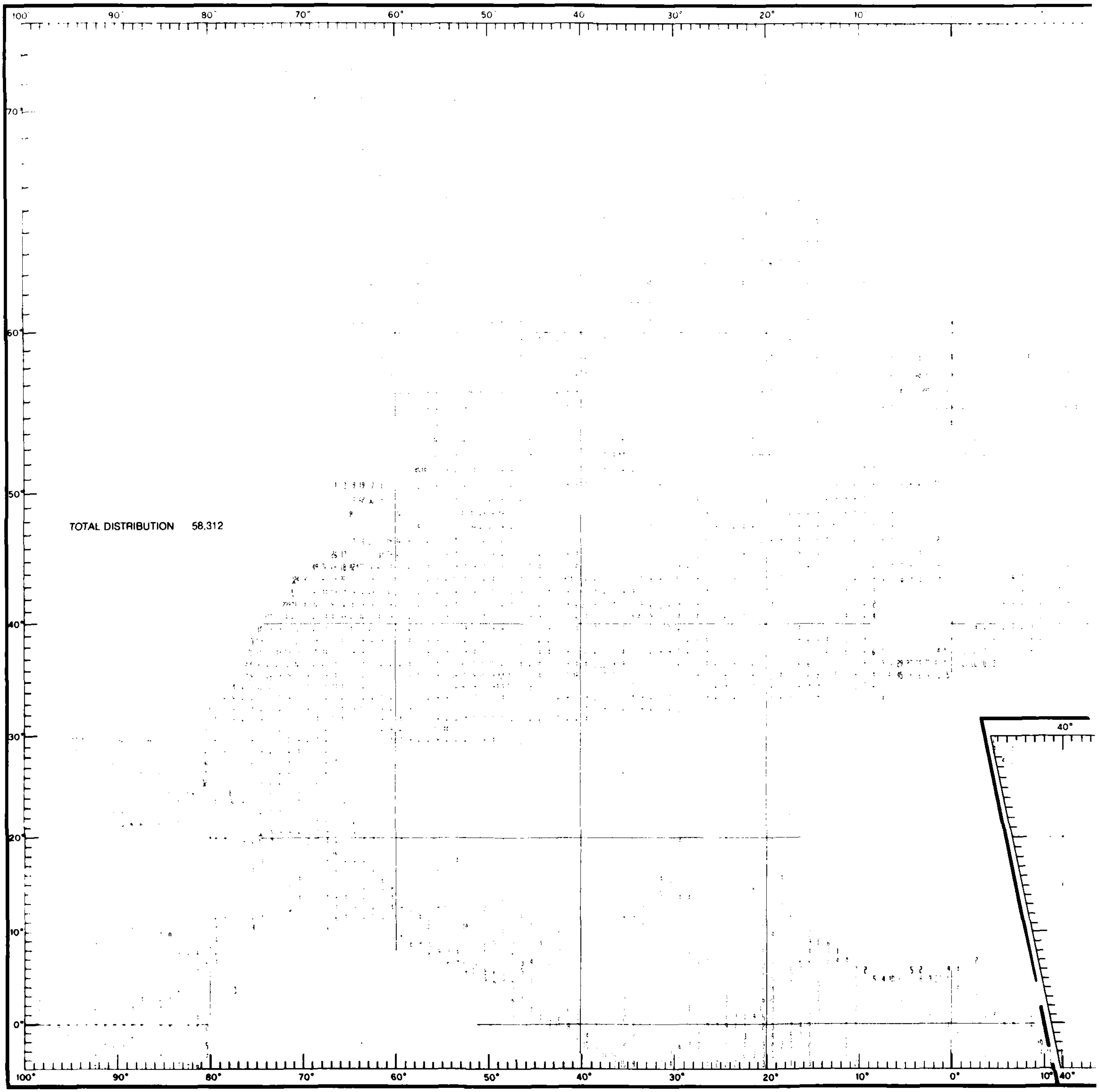
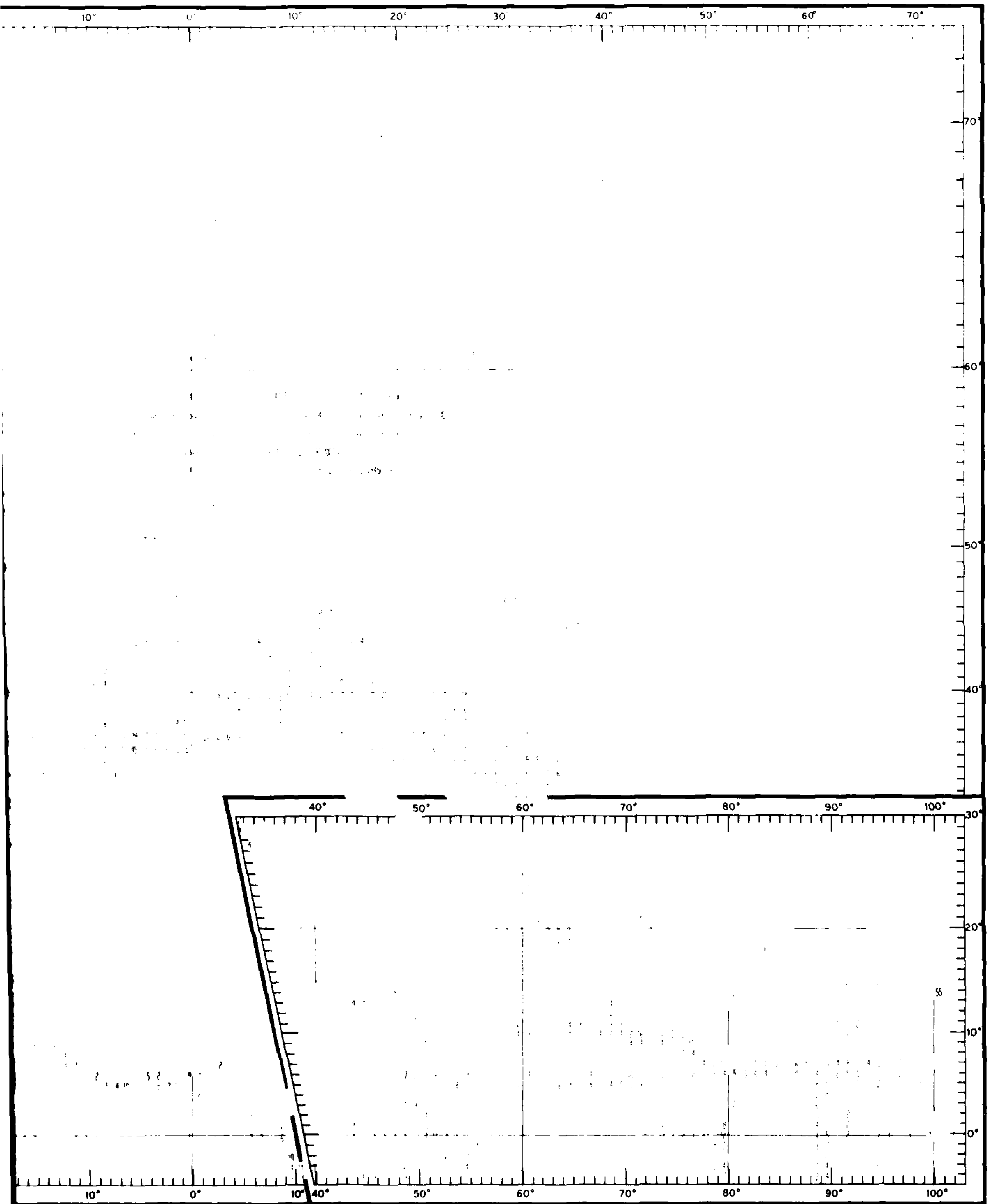


FIGURE 113. SEPTEMBER DATA DISTRIBUTION OF TEMPERATURES AT THE SURFA



IBUTION OF TEMPERATURES AT THE SURFACE

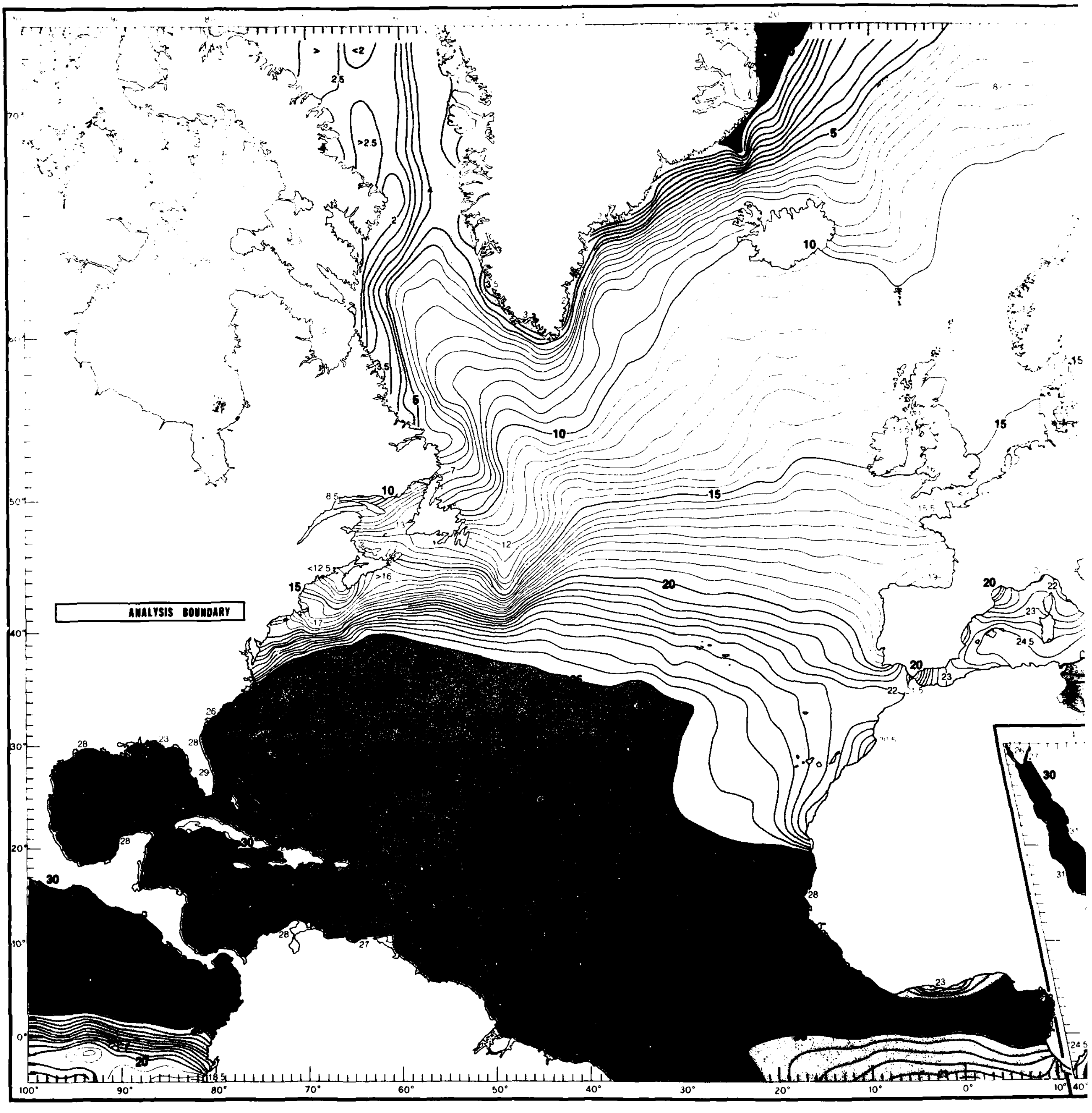
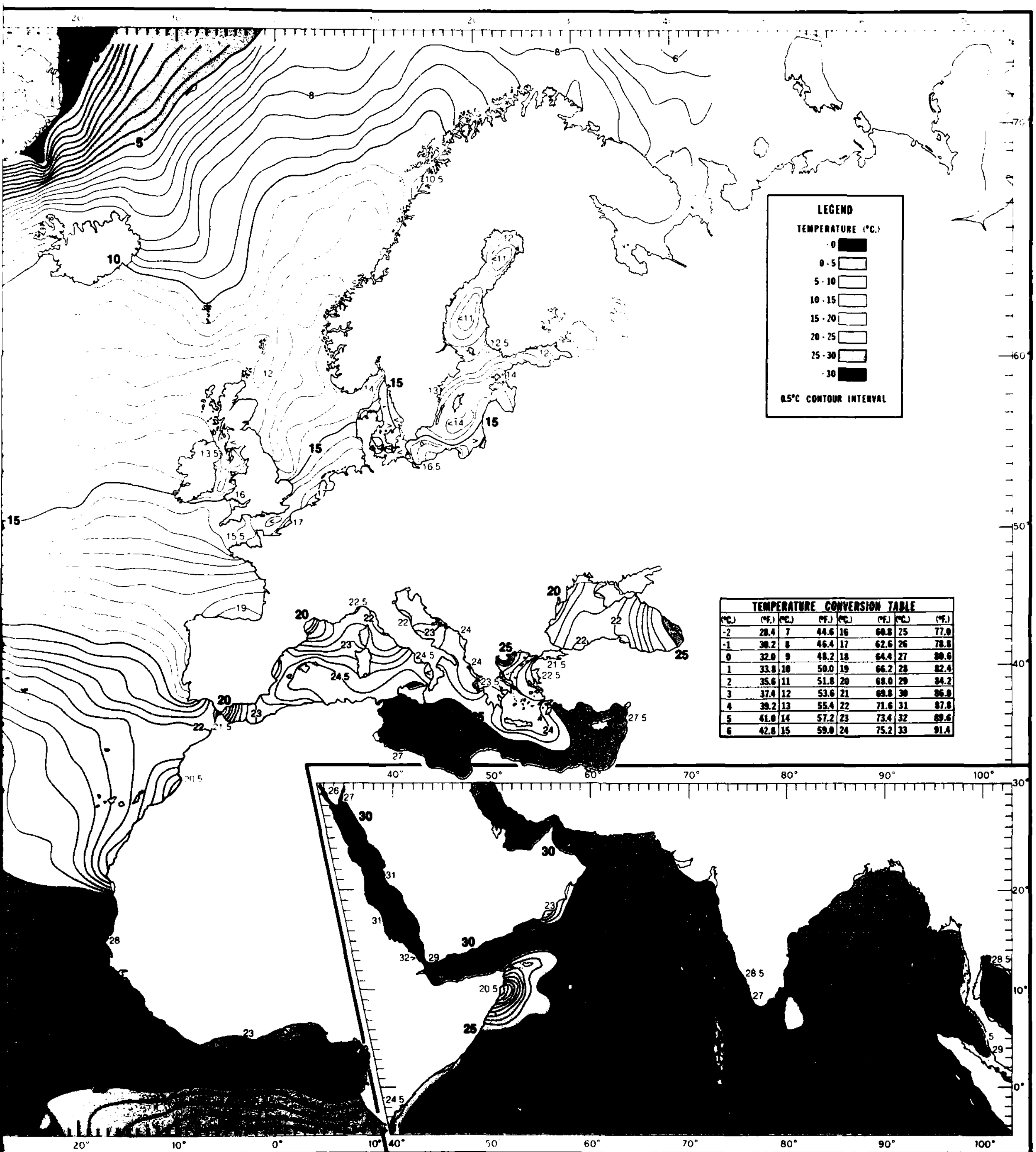


FIGURE 114. SEPTEMBER MEAN TEMPERATURES AT THE SURFACE



TEMPERATURE CONVERSION TABLE							
(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

EMBER MEAN TEMPERATURES AT THE SURFACE

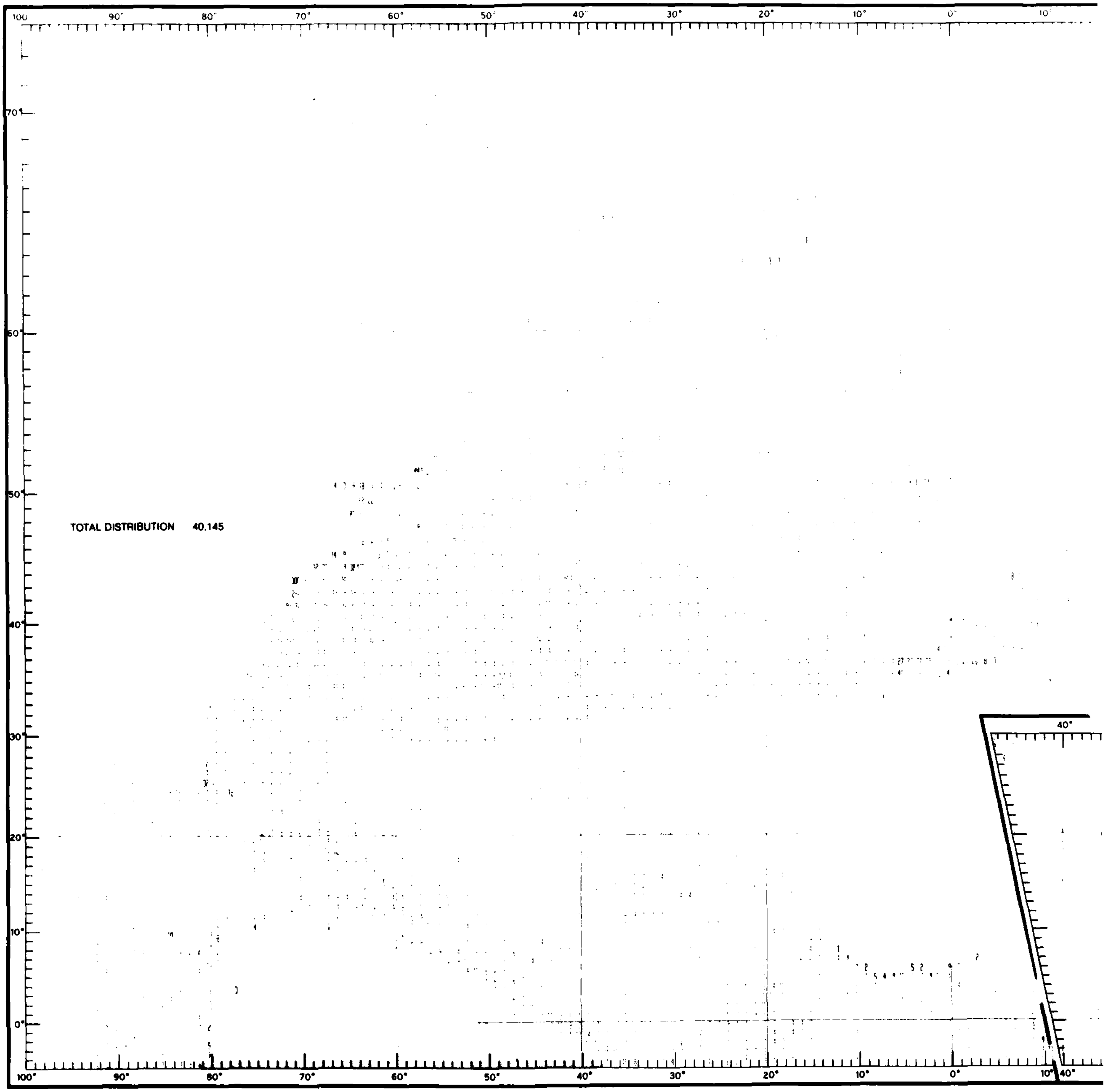
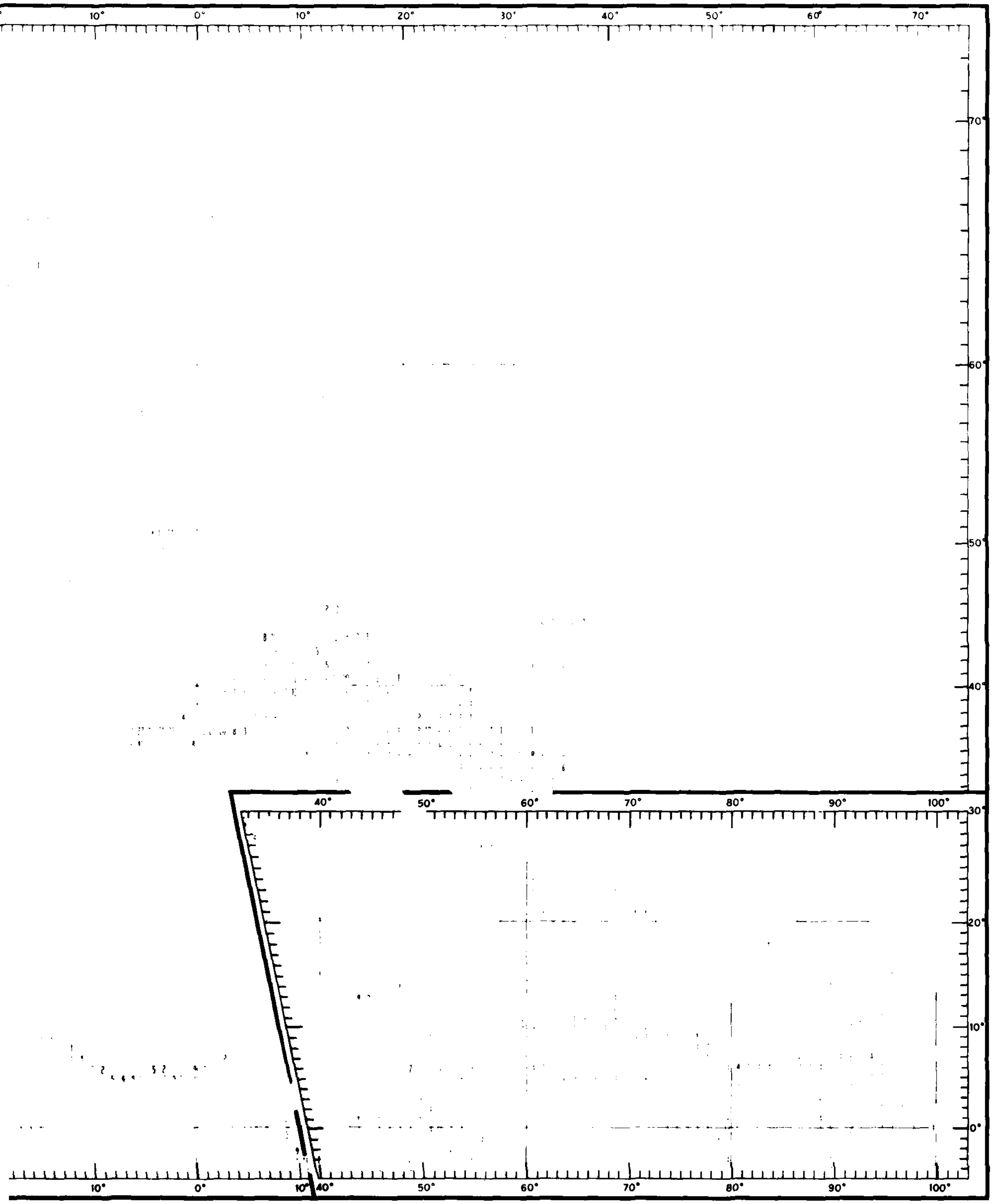


FIGURE 115. SEPTEMBER DATA DISTRIBUTION OF TEMPERATURES AT 100 FT (30 M



ːTRIBUTION OF TEMPERATURES AT 100 FT (30 M)

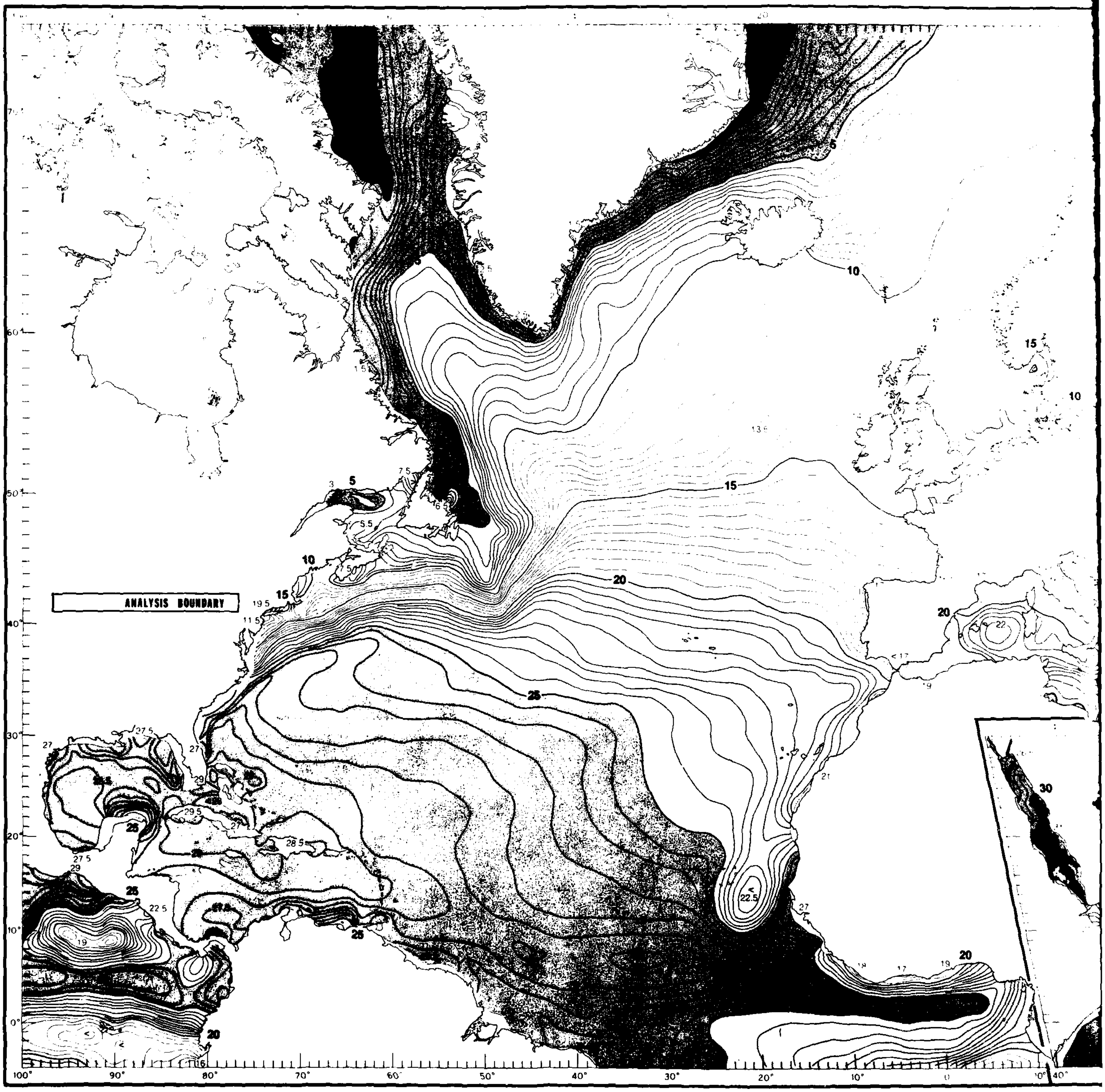
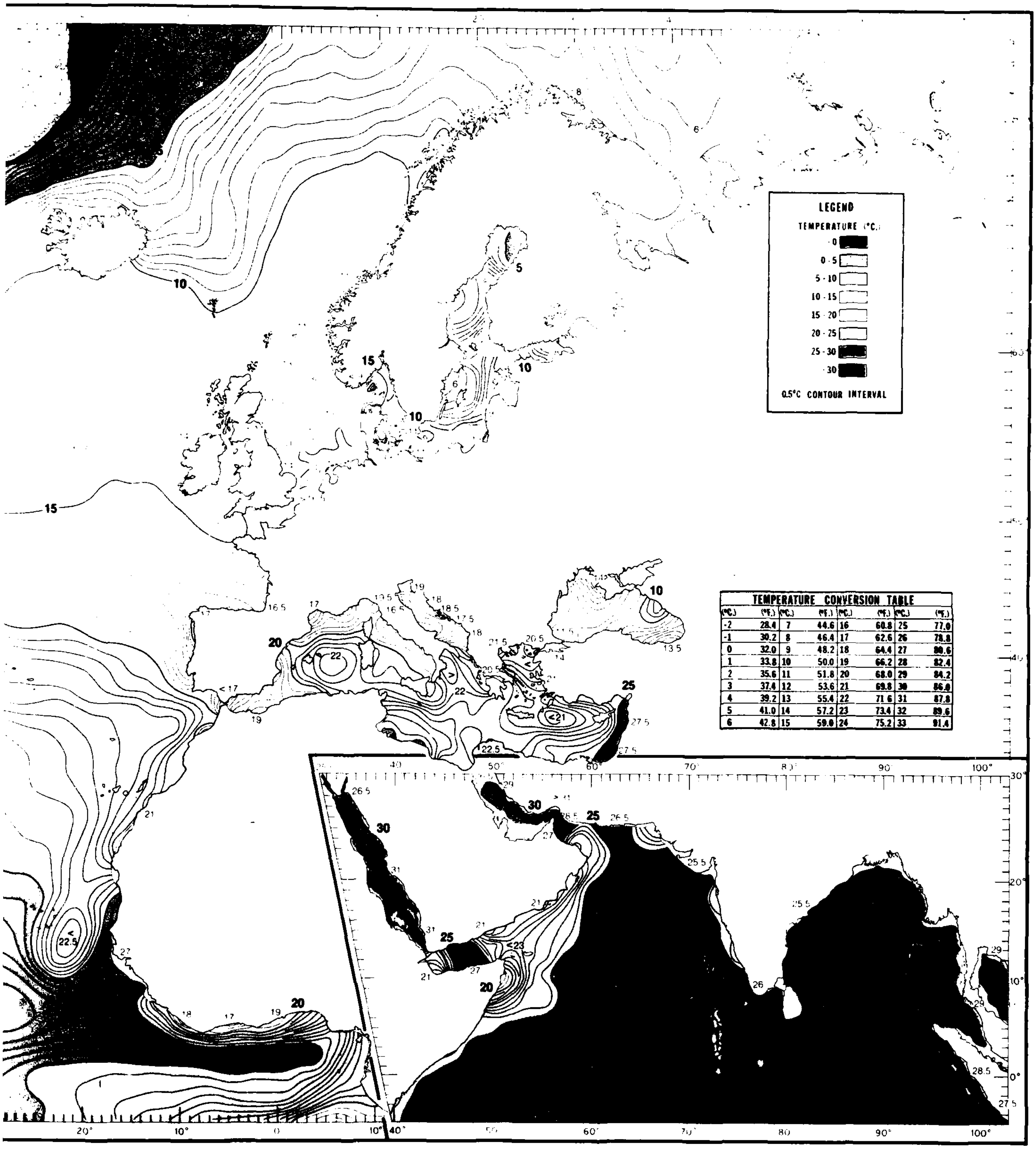


FIGURE 116. SEPTEMBER MEAN TEMPERATURES AT 100 FT (30 M)



TEMPERATURE CONVERSION TABLE

(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

PTEMBER MEAN TEMPERATURES AT 100 FT (30 M)

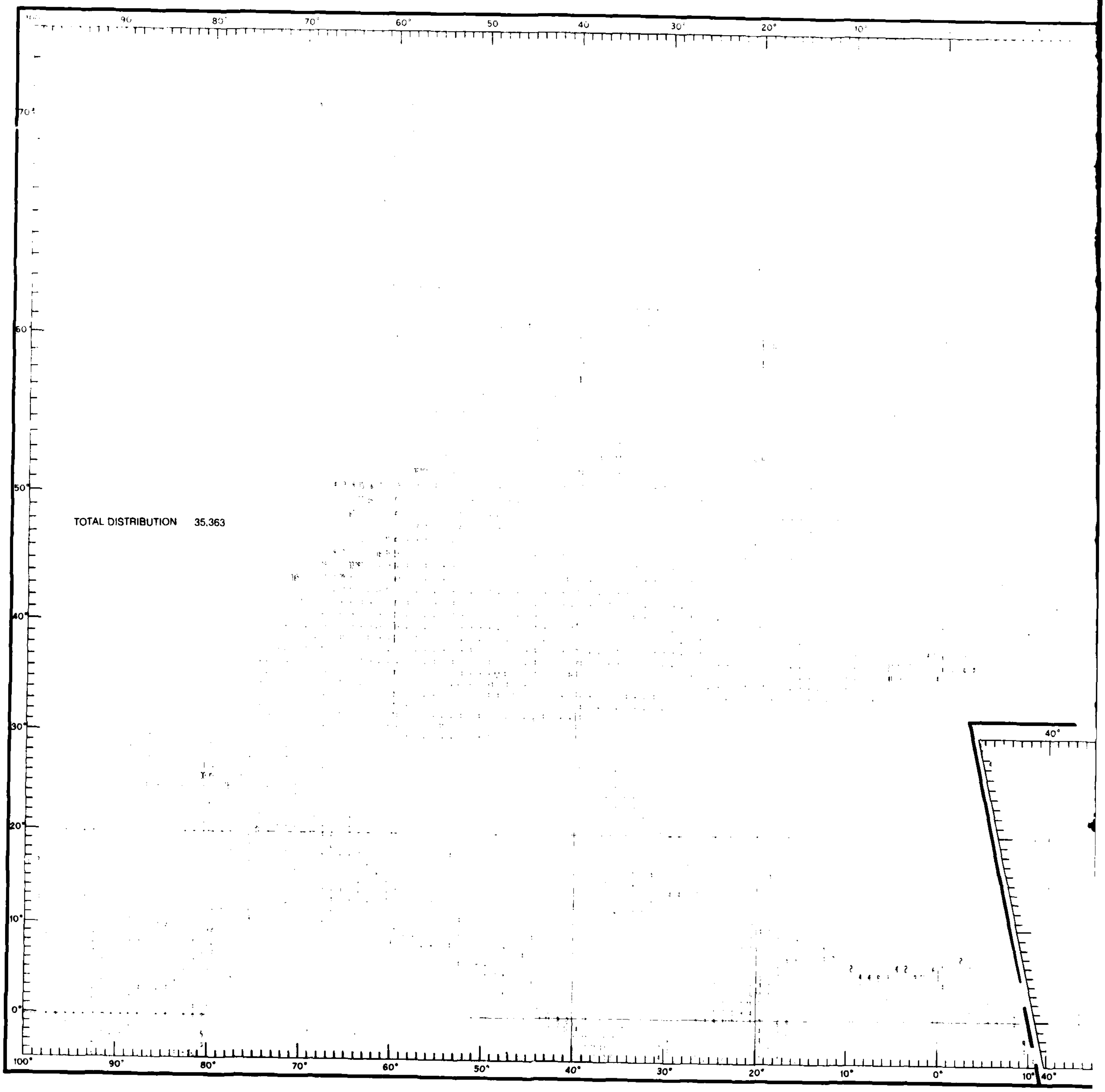
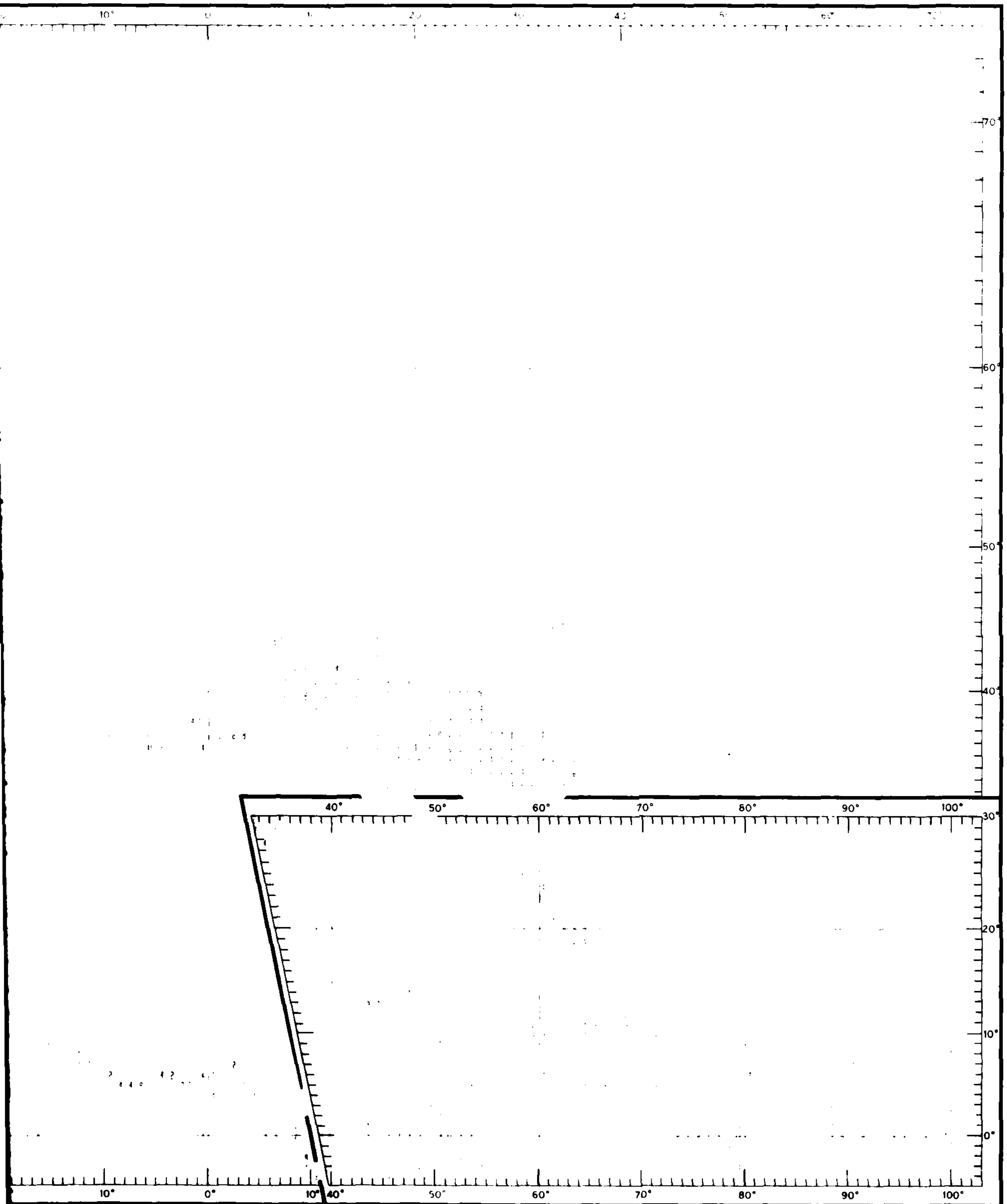


FIGURE 117. SEPTEMBER DATA DISTRIBUTION OF TEMPERATURES AT 200 FT (60 M)



STRIBUTION OF TEMPERATURES AT 200 FT (60 M)

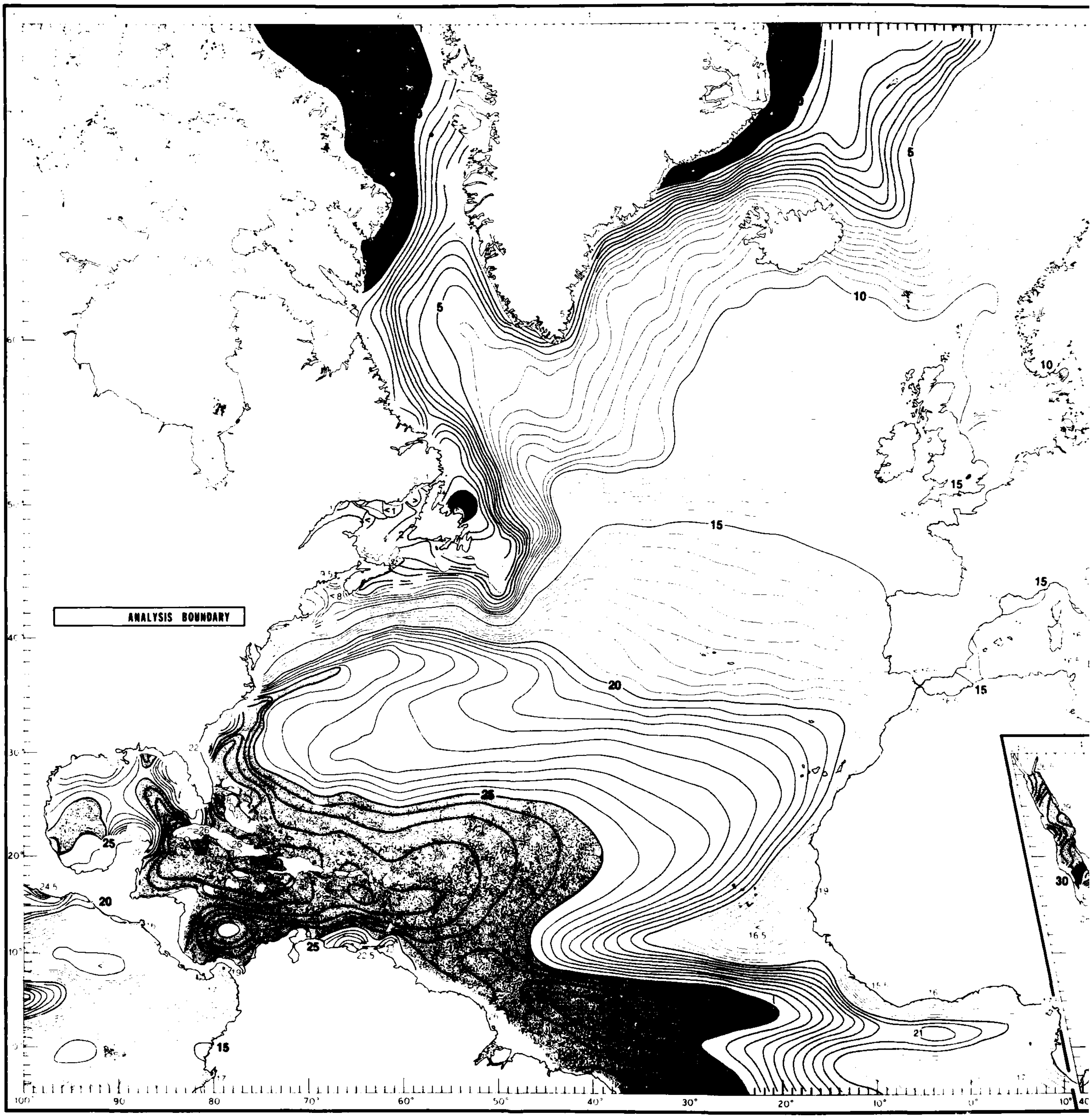
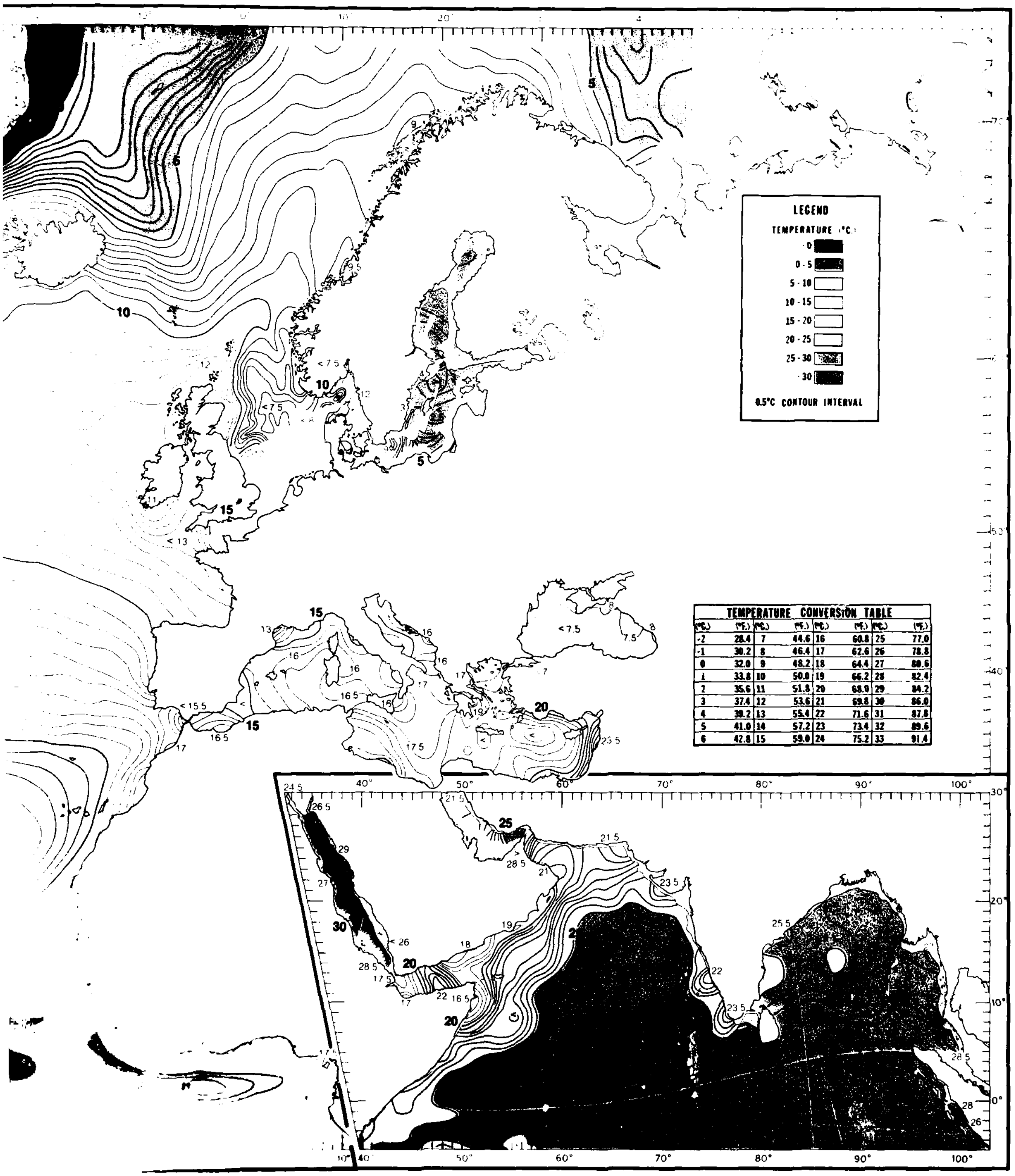


FIGURE 118. SEPTEMBER MEAN TEMPERATURES AT 200 FT (60 M)



TEMPERATURE CONVERSION TABLE

(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

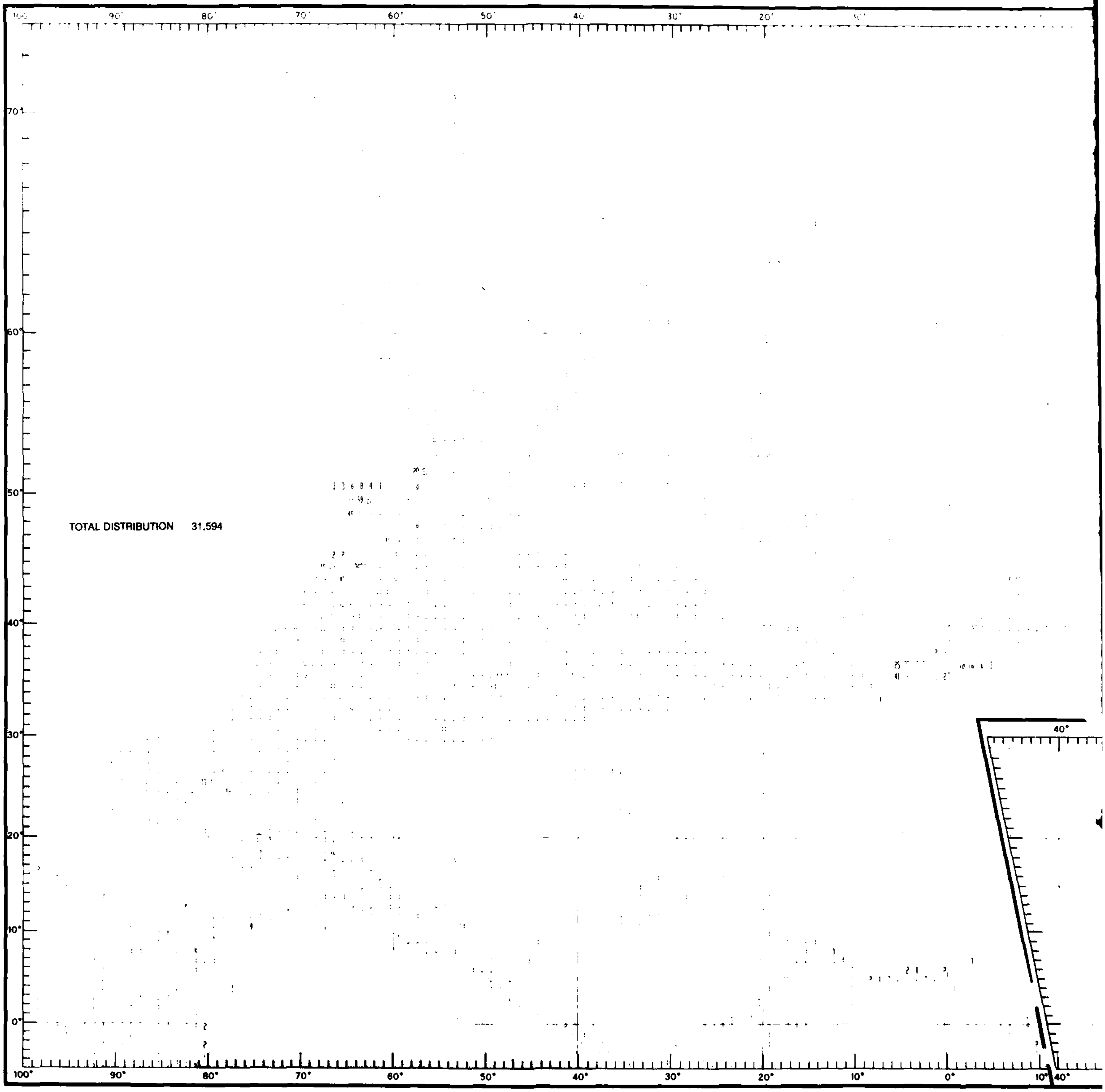
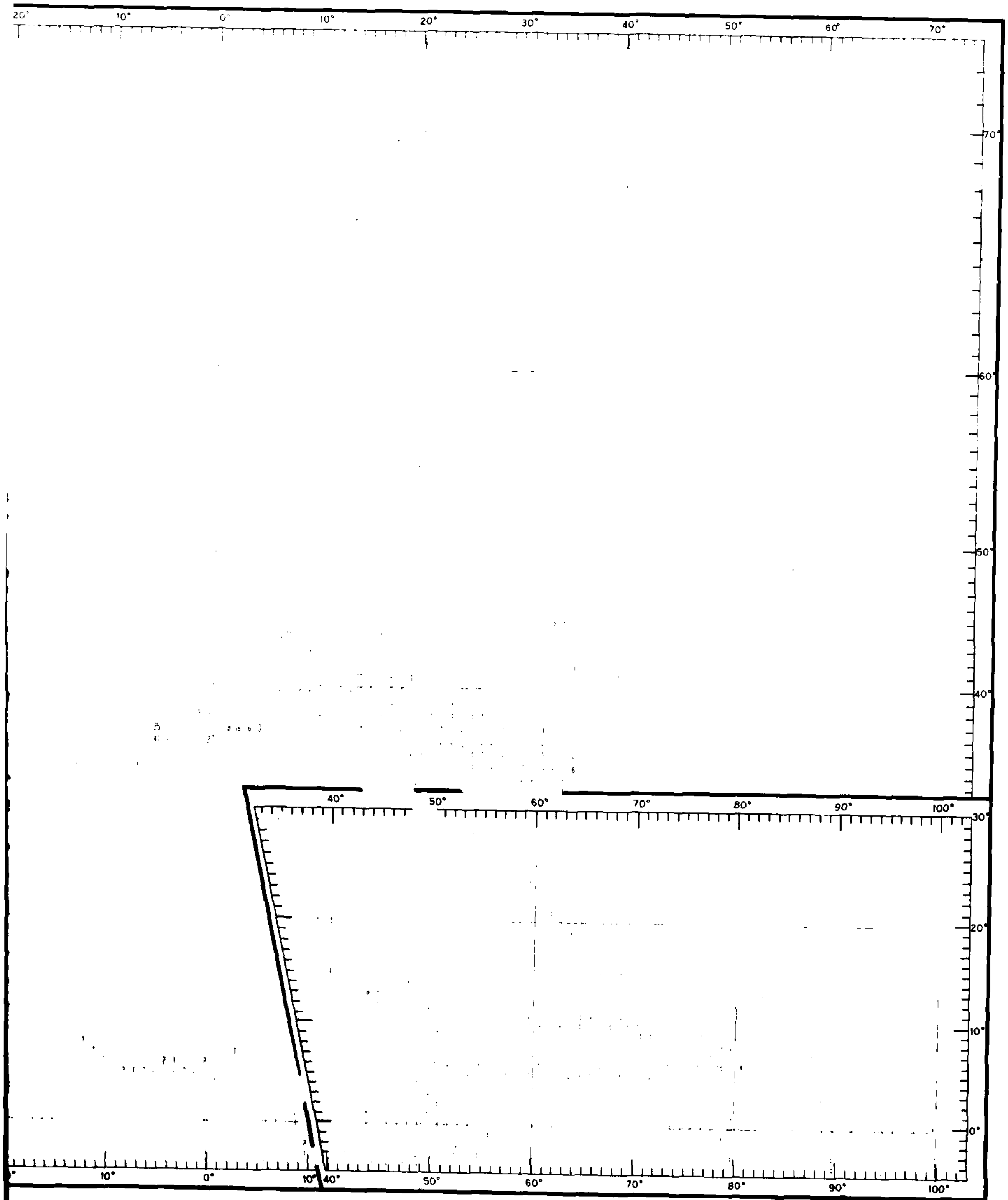


FIGURE 119. SEPTEMBER DATA DISTRIBUTION OF TEMPERATURES AT 300 FT (90 M)



STRIBUTION OF TEMPERATURES AT 300 FT (90 M)

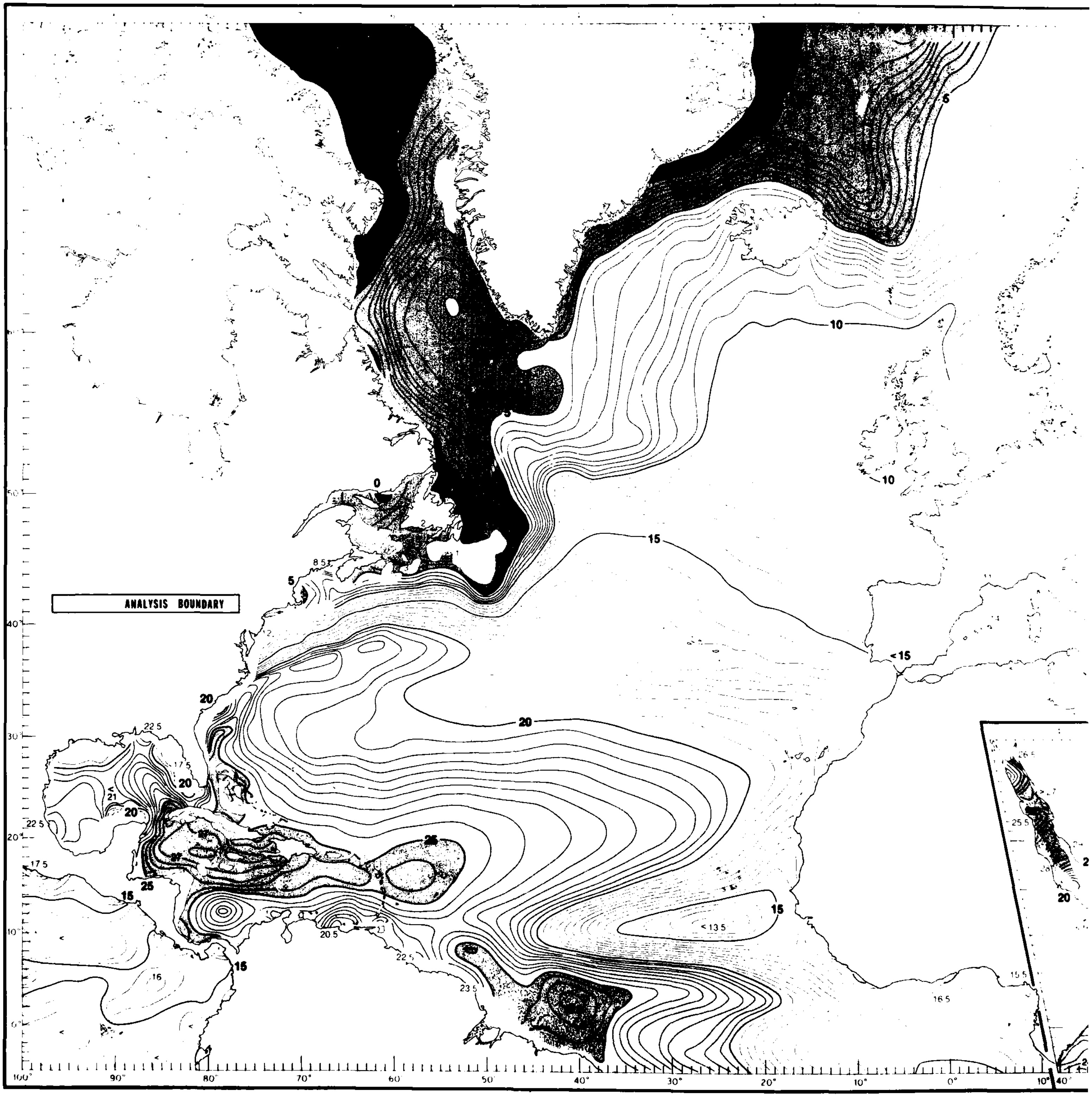
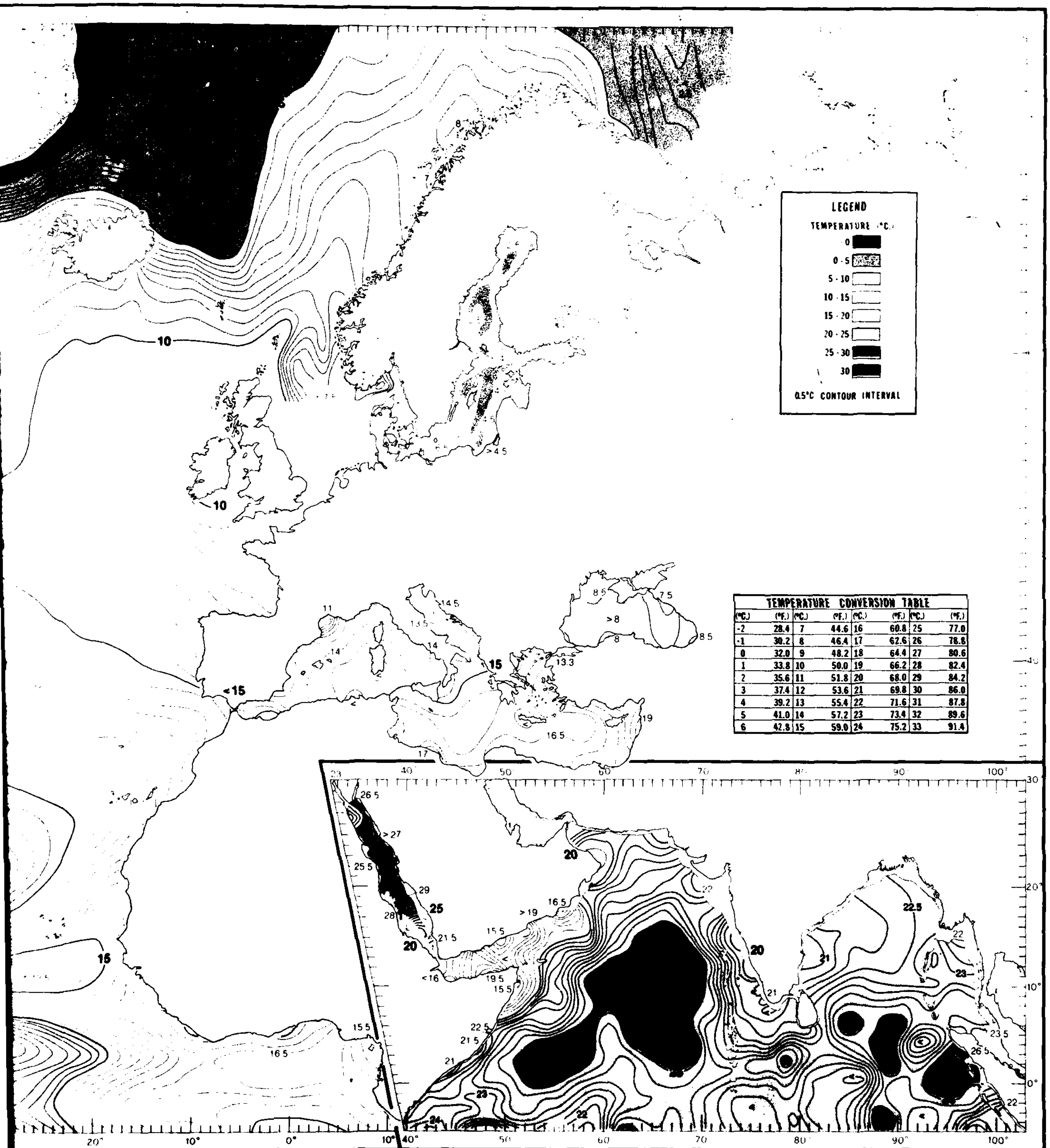


FIGURE 120. SEPTEMBER MEAN TEMPERATURES AT 300 FT (90 M)



TEMPERATURE CONVERSION TABLE							
(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

TEMBER MEAN TEMPERATURES AT 300 FT (90 M)

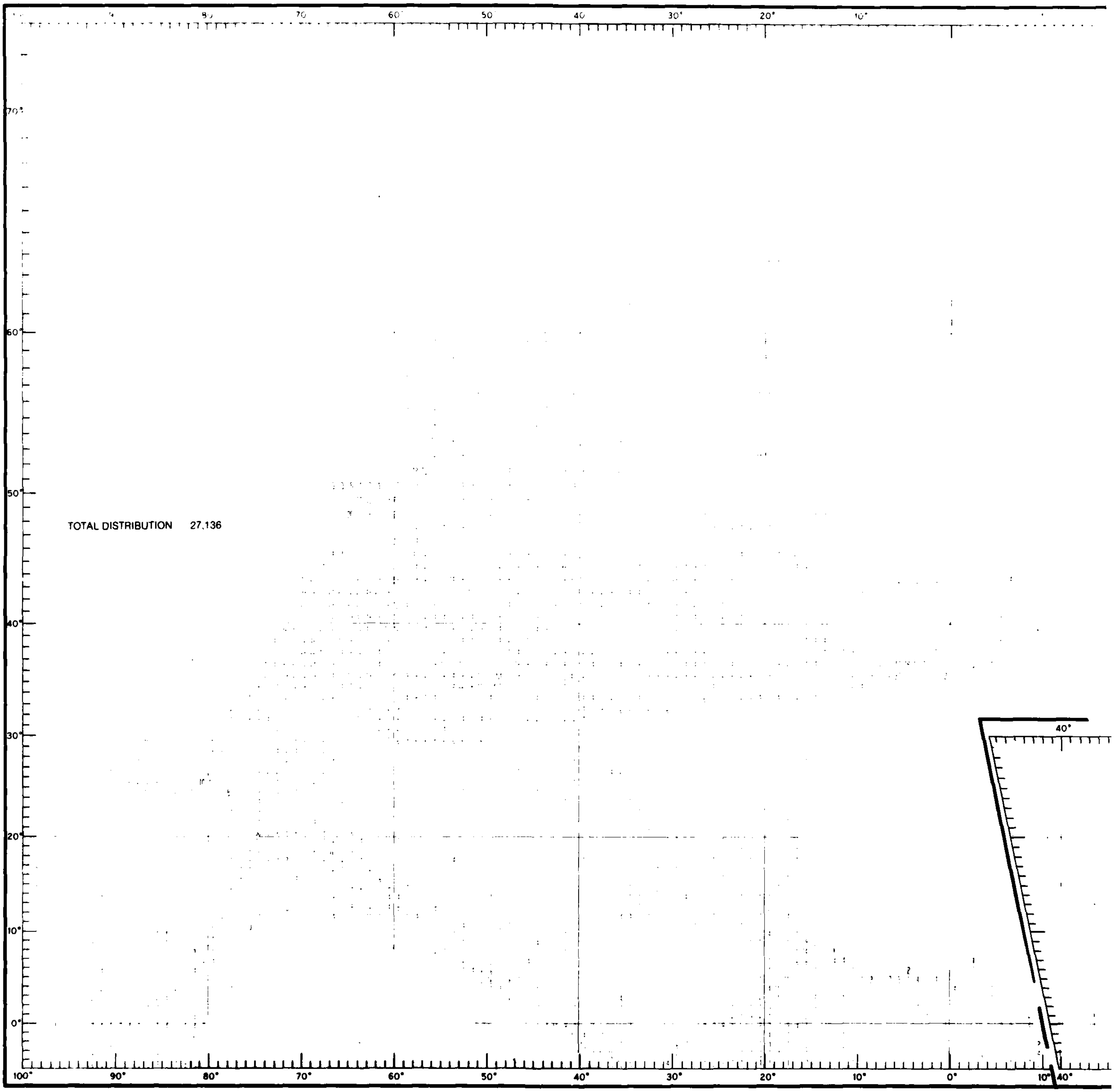
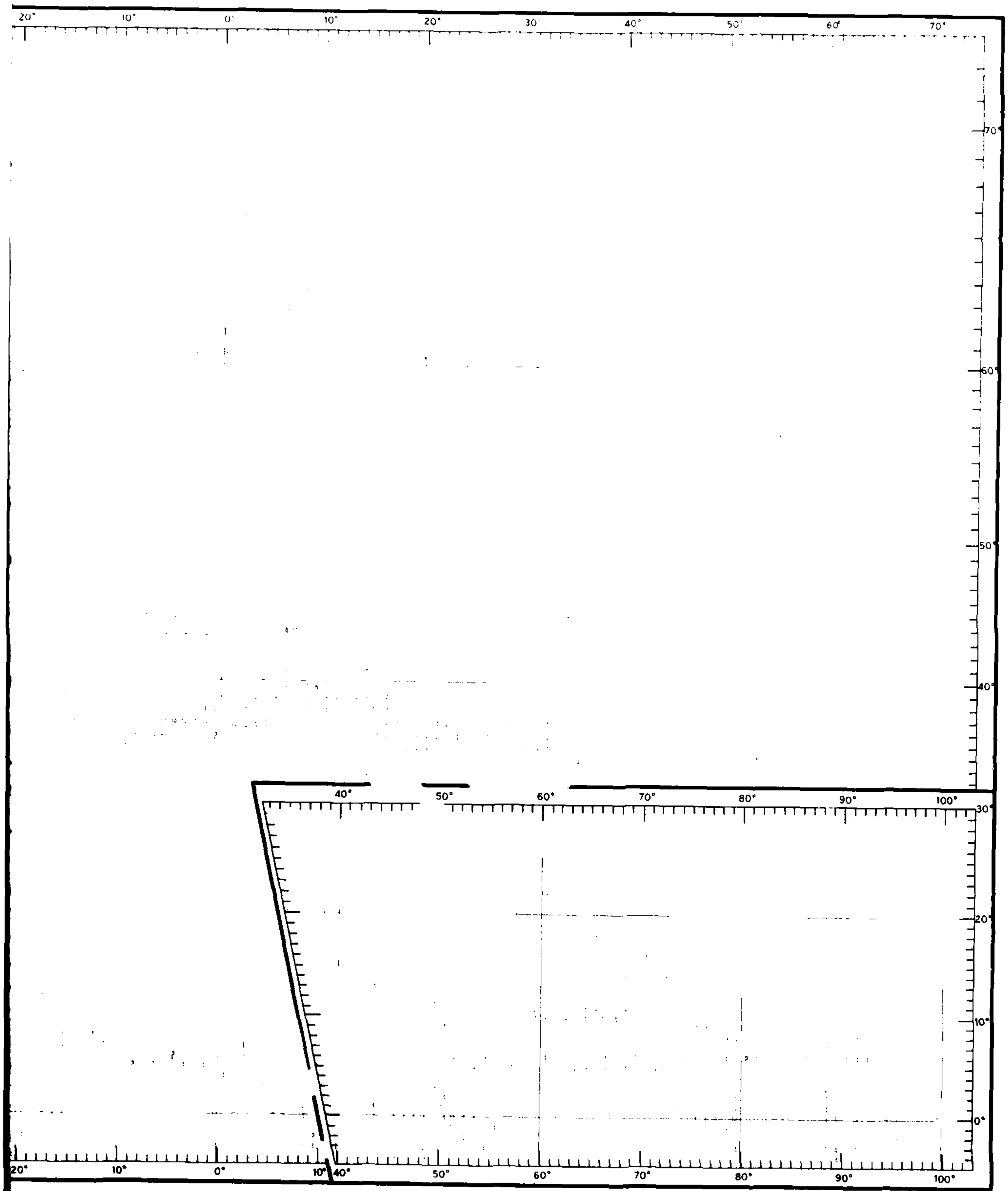


FIGURE 121. SEPTEMBER DATA DISTRIBUTION OF TEMPERATURES AT 400 FT (120 M)



ISTRIBUTION OF TEMPERATURES AT 400 FT (120 M)

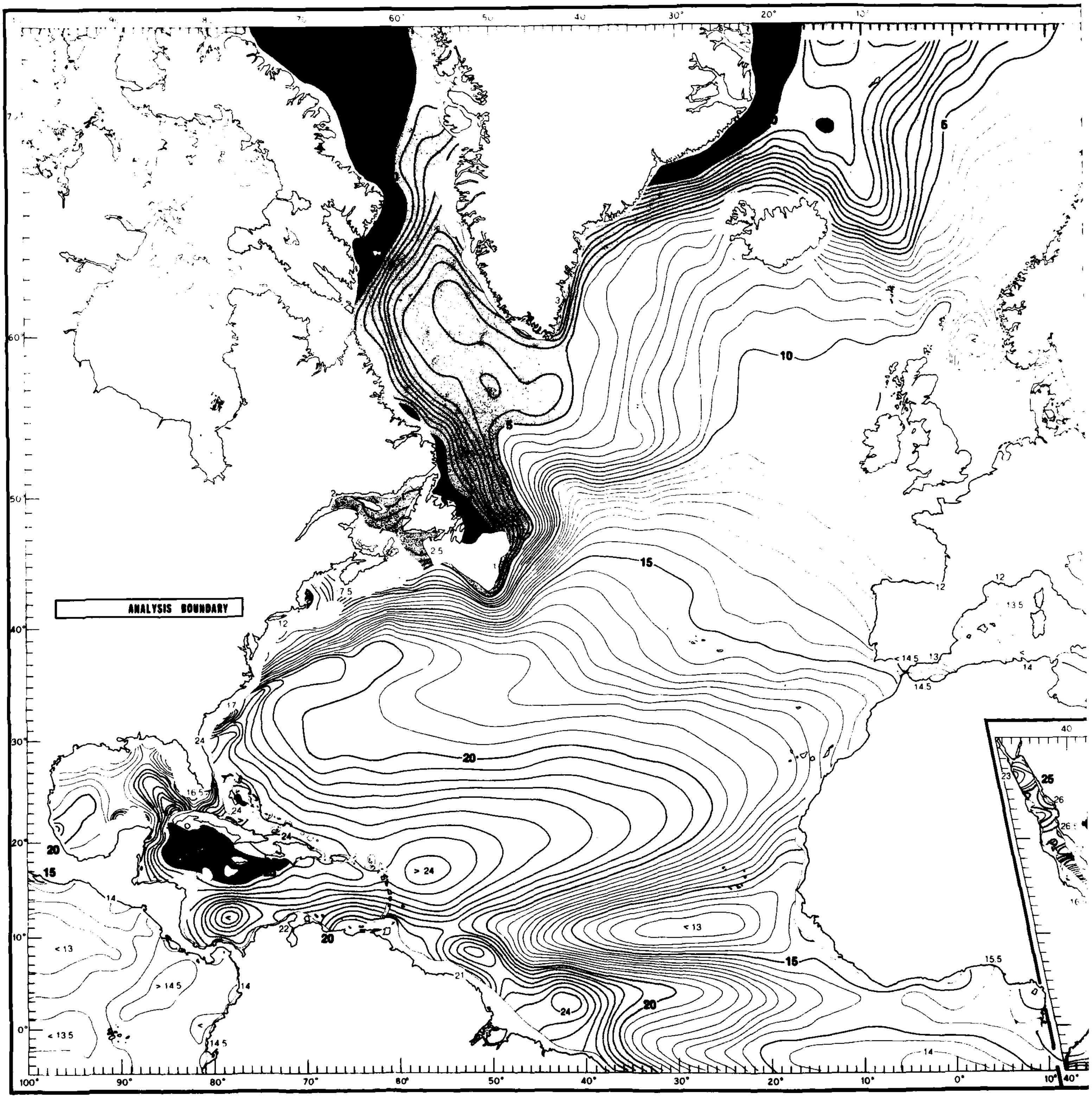
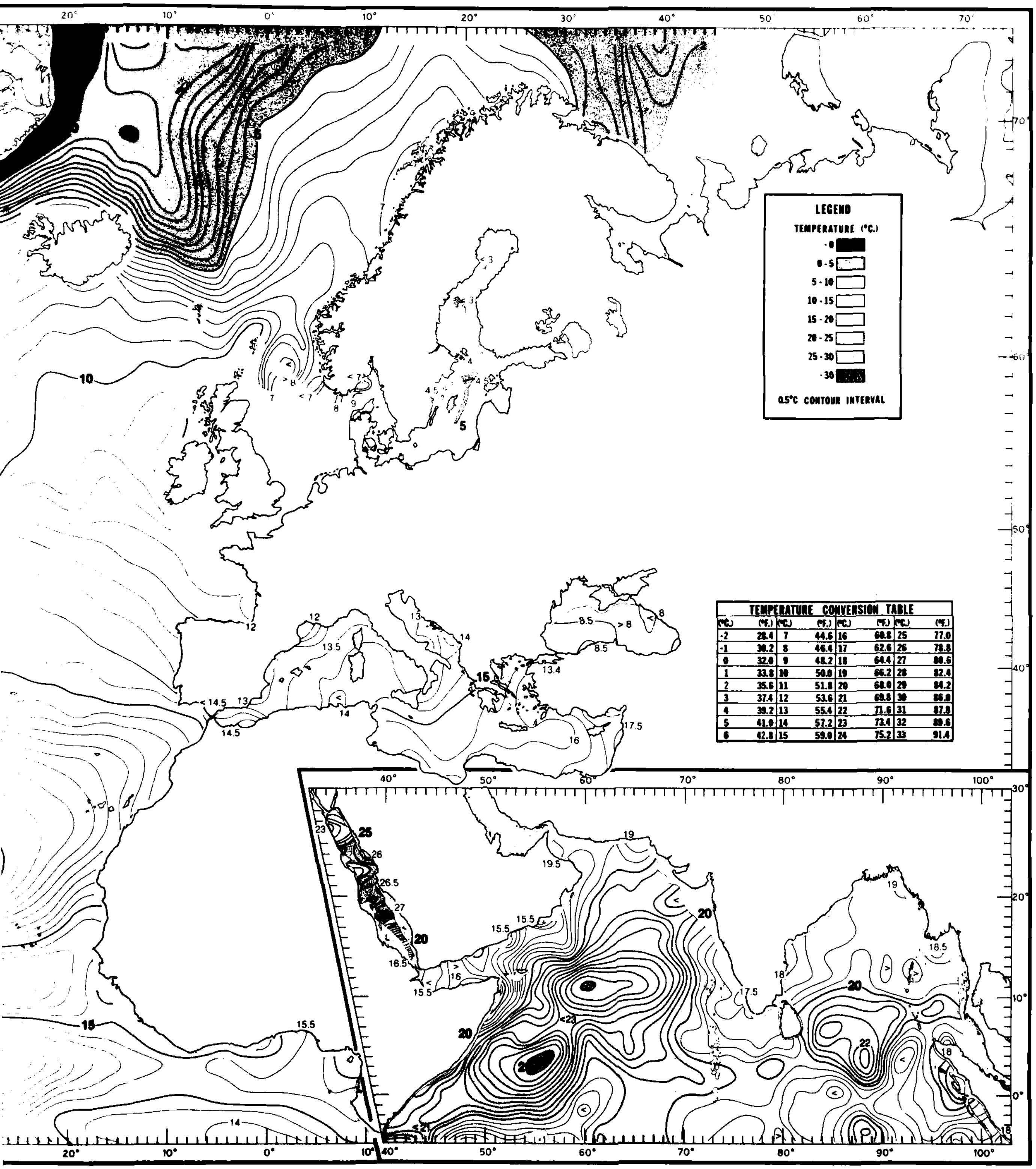


FIGURE 122. SEPTEMBER MEAN TEMPERATURES AT 400 FT (120 M)



TEMPERATURE CONVERSION TABLE

(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

MBER MEAN TEMPERATURES AT 400 FT (120 M)

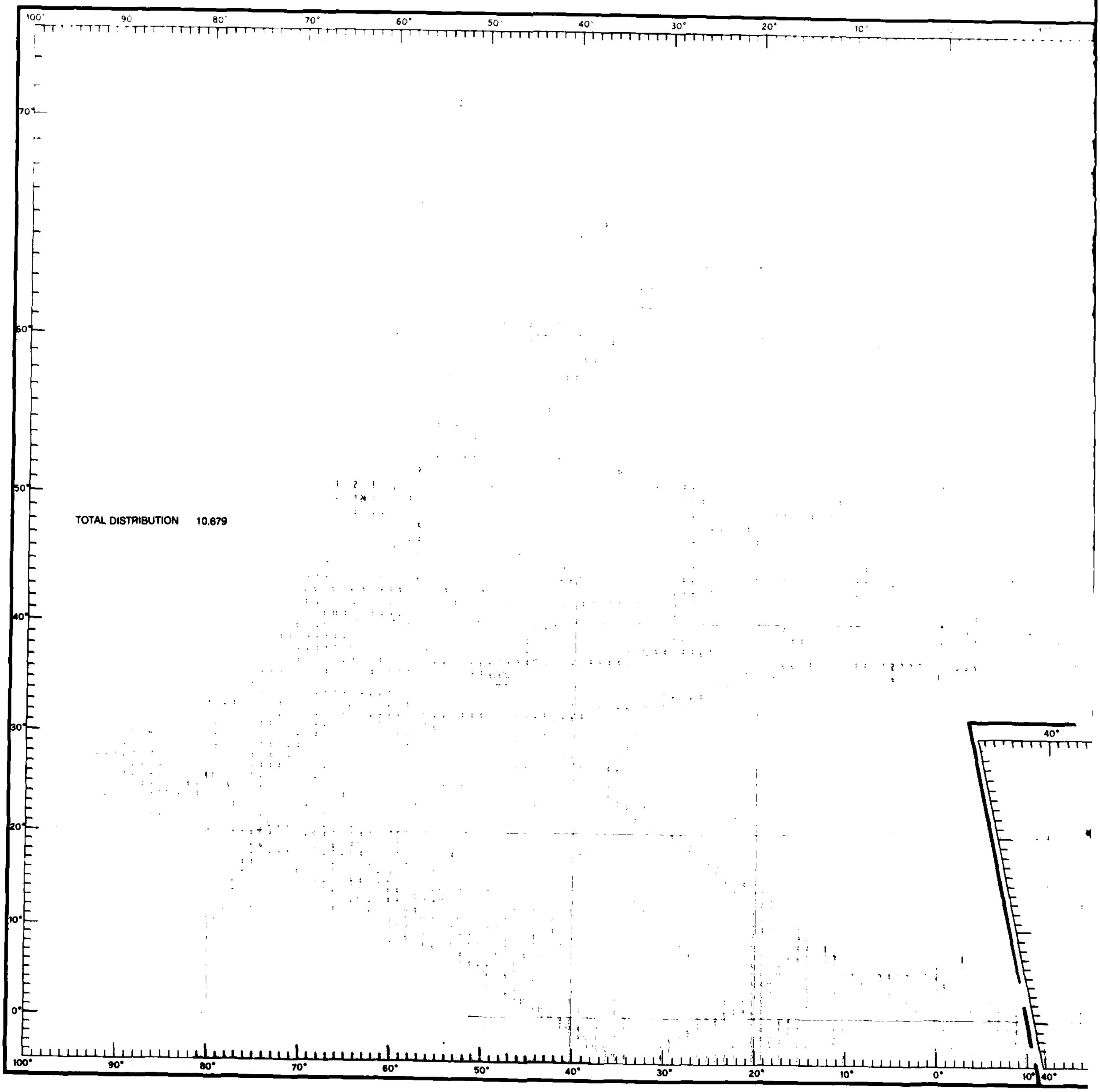
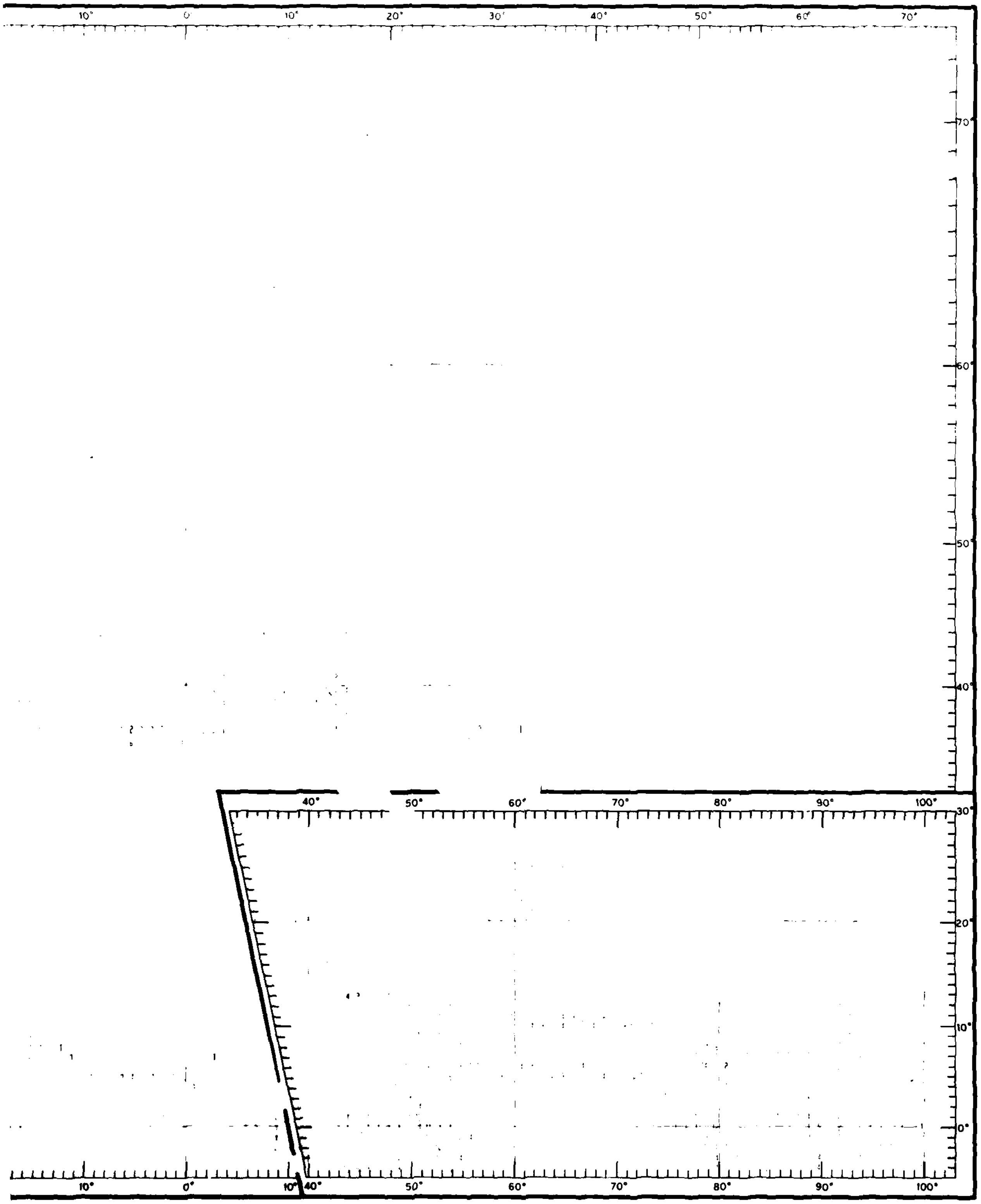


FIGURE 123. SEPTEMBER DATA DISTRIBUTION OF TEMPERATURES AT 492 FT (150 M



IBUTION OF TEMPERATURES AT 492 FT (150 M)

12

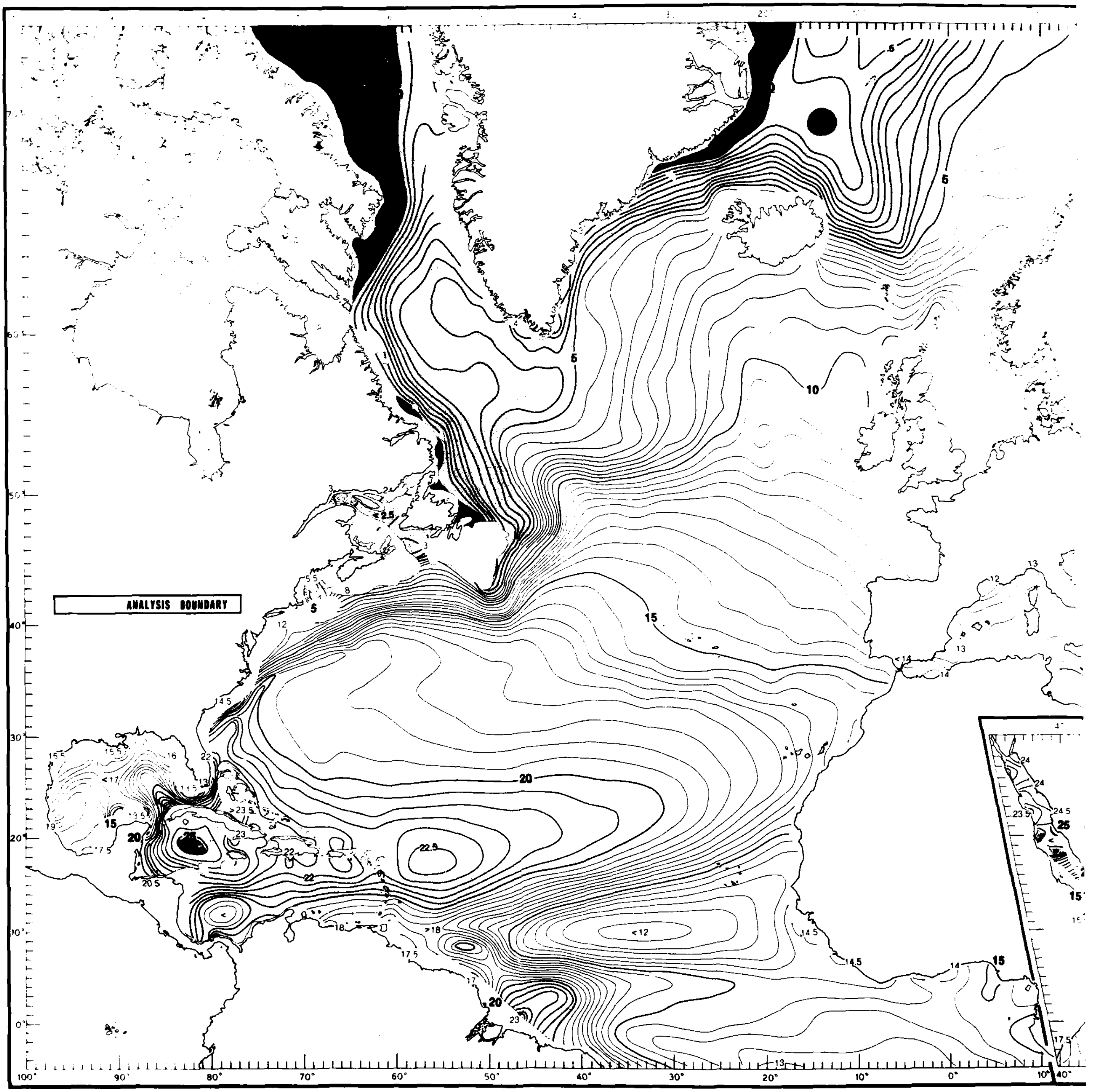
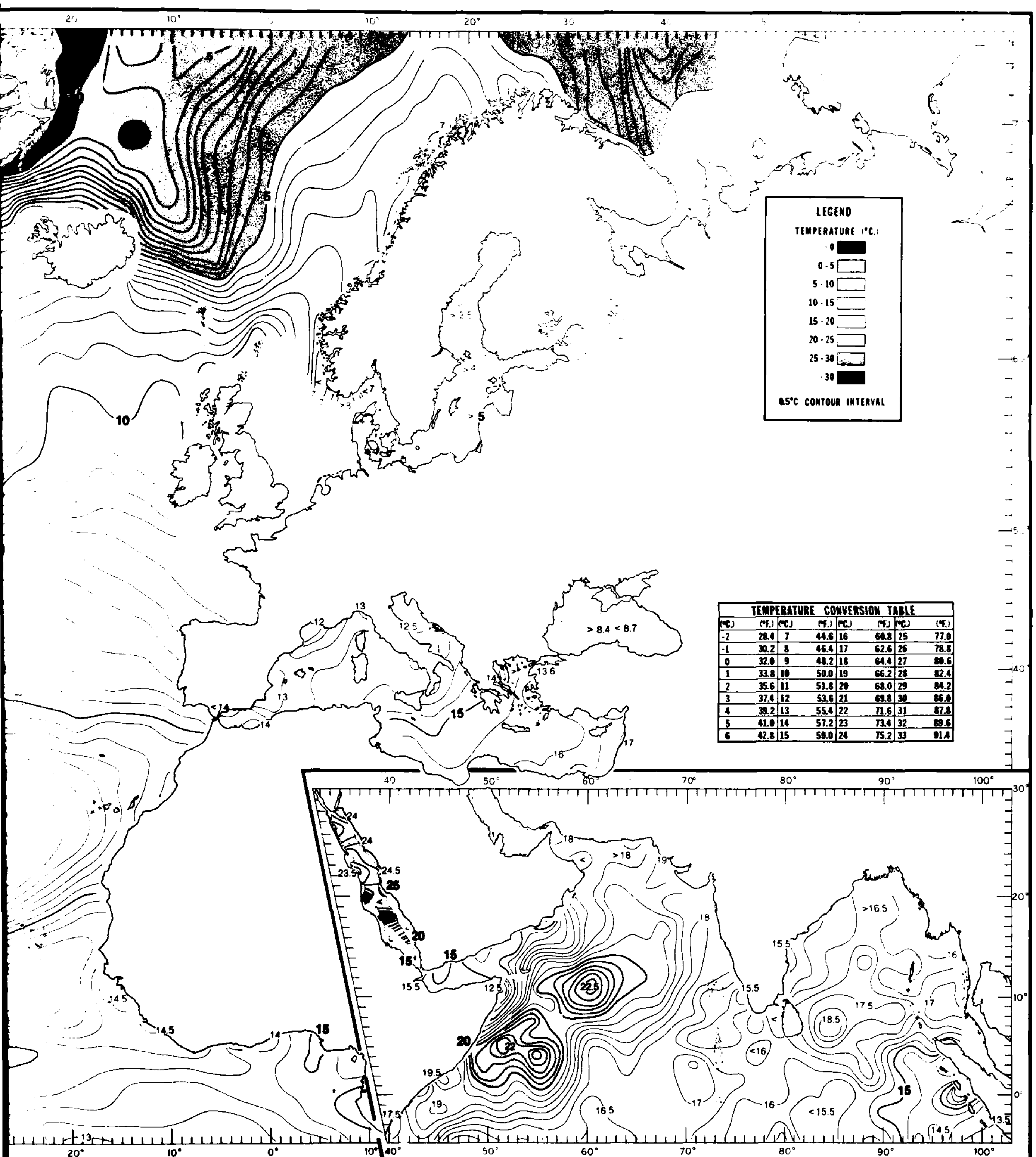


FIGURE 124. SEPTEMBER MEAN TEMPERATURES AT 492 FT (150 M)



TEMPERATURE CONVERSION TABLE							
(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

EMBER MEAN TEMPERATURES AT 492 FT (150 M)

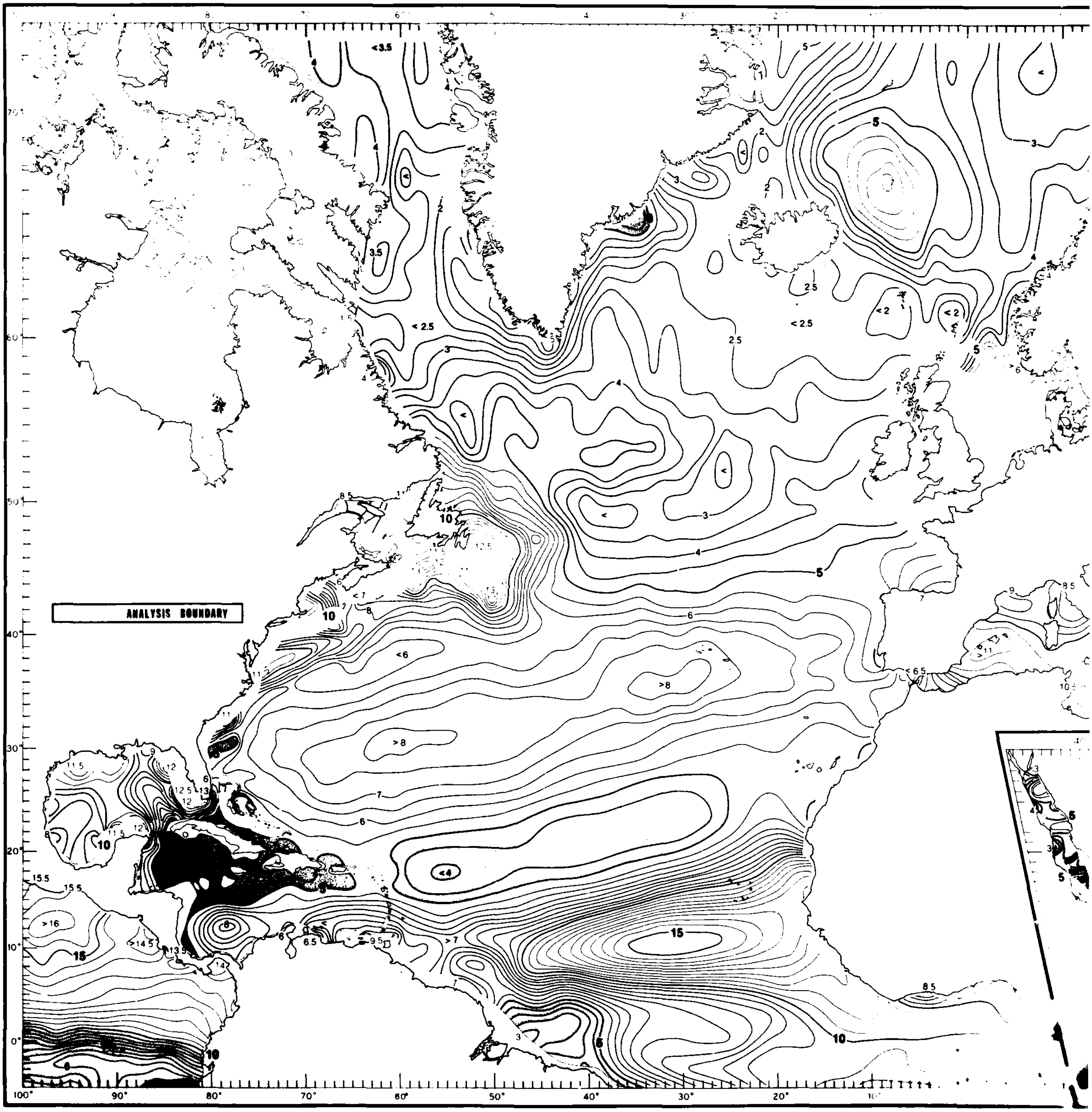
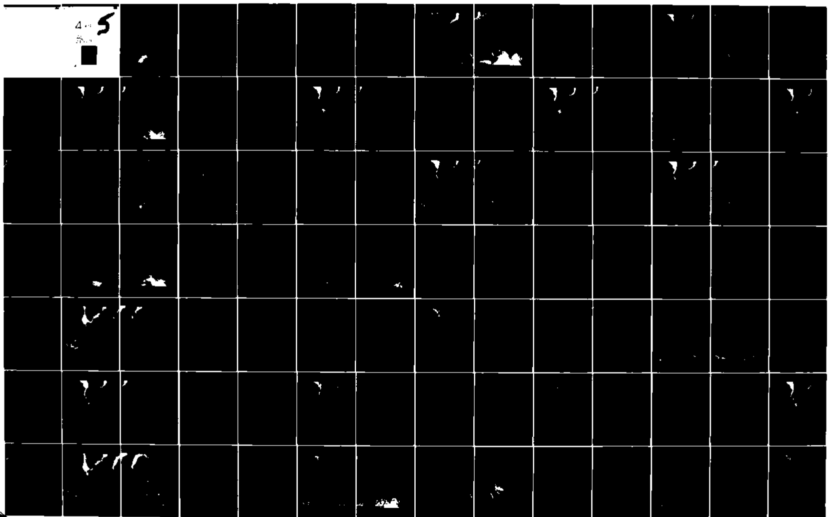
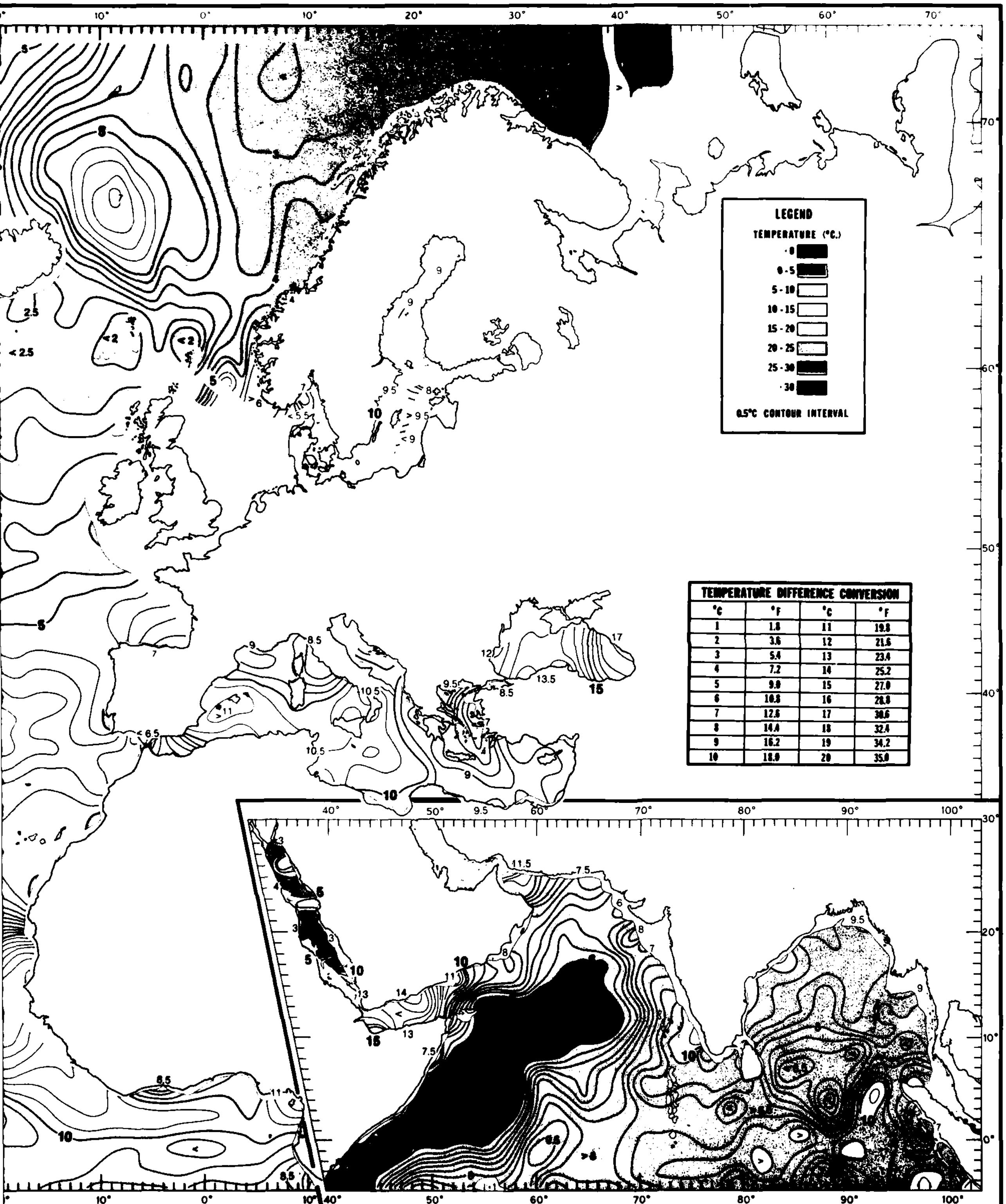


FIGURE 125. SEPTEMBER TEMPERATURE DIFFERENCE BETWEEN

AD-A087 571 NAVAL OCEANOGRAPHIC OFFICE NSTL STATION MS F/G 8/10
ATLAS OF NORTH ATLANTIC-INDIAN OCEAN MONTHLY MEAN TEMPERATURES --ETC(U)
1979 M K ROBINSON, R A BAUER, E H SCHROEDER
UNCLASSIFIED NOO-RP-18 NL





TEMPERATURE DIFFERENCE CONVERSION			
°C	°F	°C	°F
1	1.8	11	19.8
2	3.6	12	21.6
3	5.4	13	23.4
4	7.2	14	25.2
5	9.0	15	27.0
6	10.8	16	28.8
7	12.6	17	30.6
8	14.4	18	32.4
9	16.2	19	34.2
10	18.0	20	36.0

FERENCE BETWEEN THE SURFACE AND 400 FT (T_0-T_{400})

2

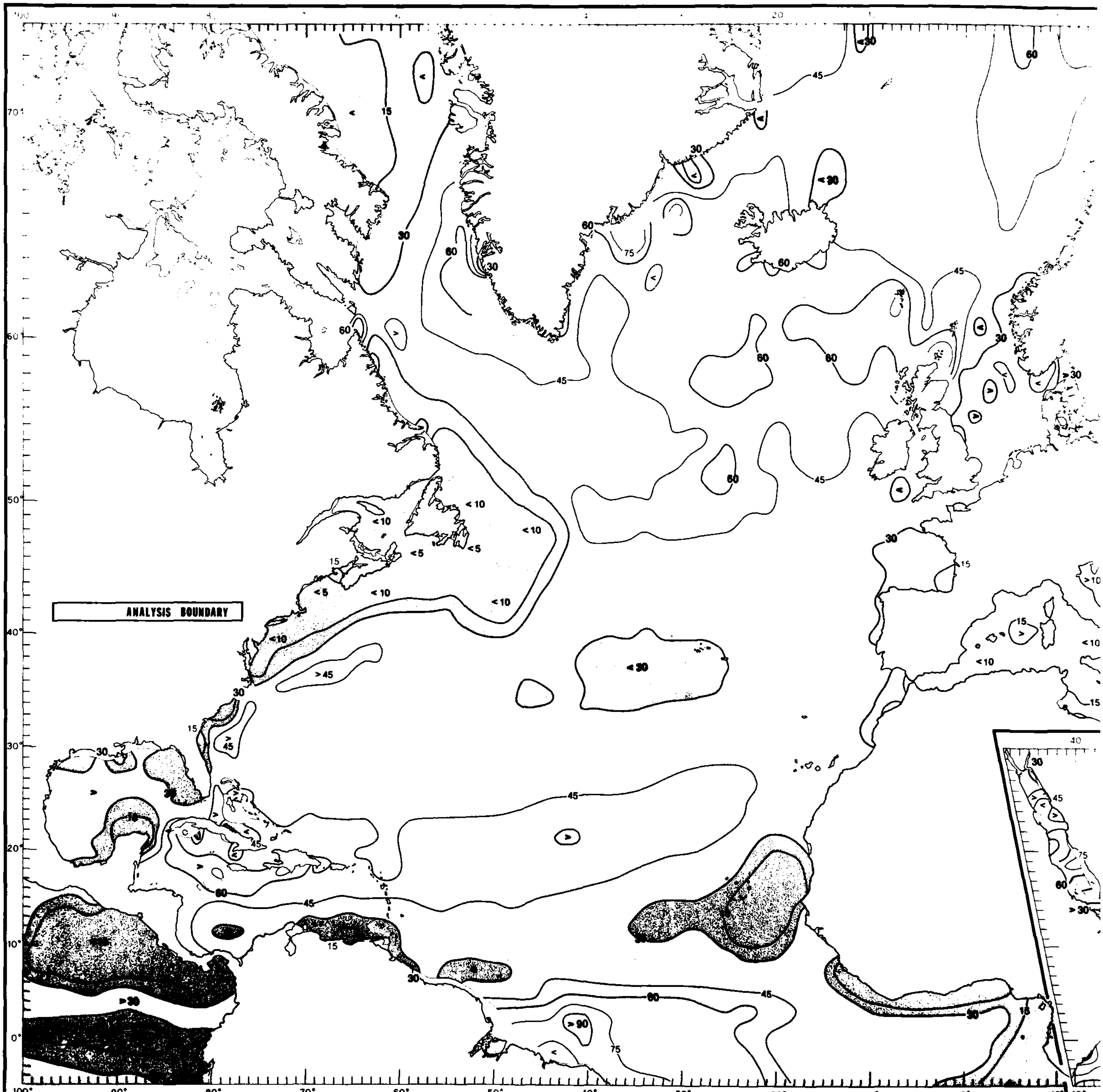
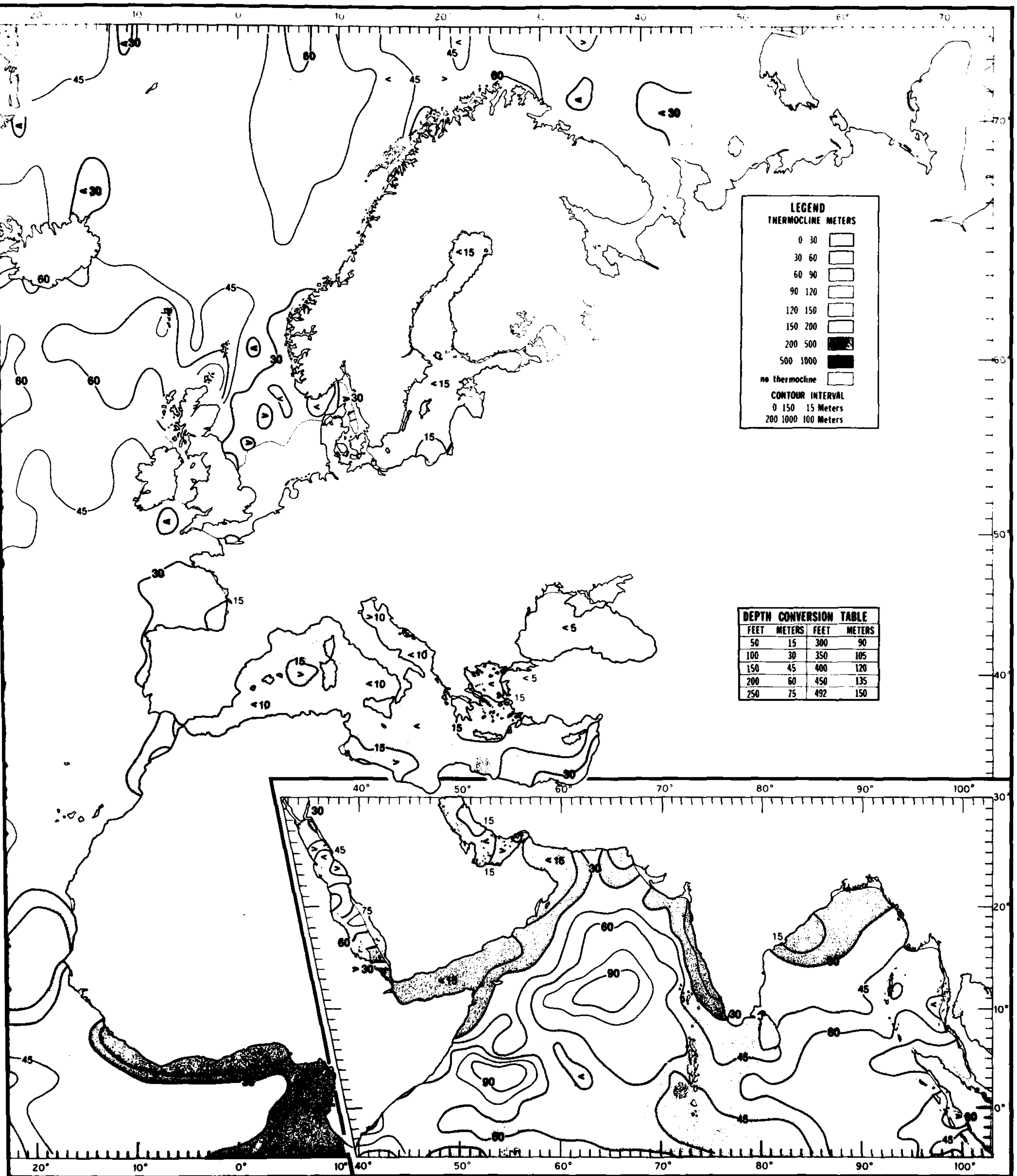


FIGURE 126. SEPTEMBER MEAN DEPTHS TO THE TOP OF THE THERMOCLINE



DEPTH CONVERSION TABLE

FEET	METERS	FEET	METERS
50	15	300	90
100	30	350	105
150	45	400	120
200	60	450	135
250	75	492	150

AN DEPTHS TO THE TOP OF THE THERMOCLINE

1 2

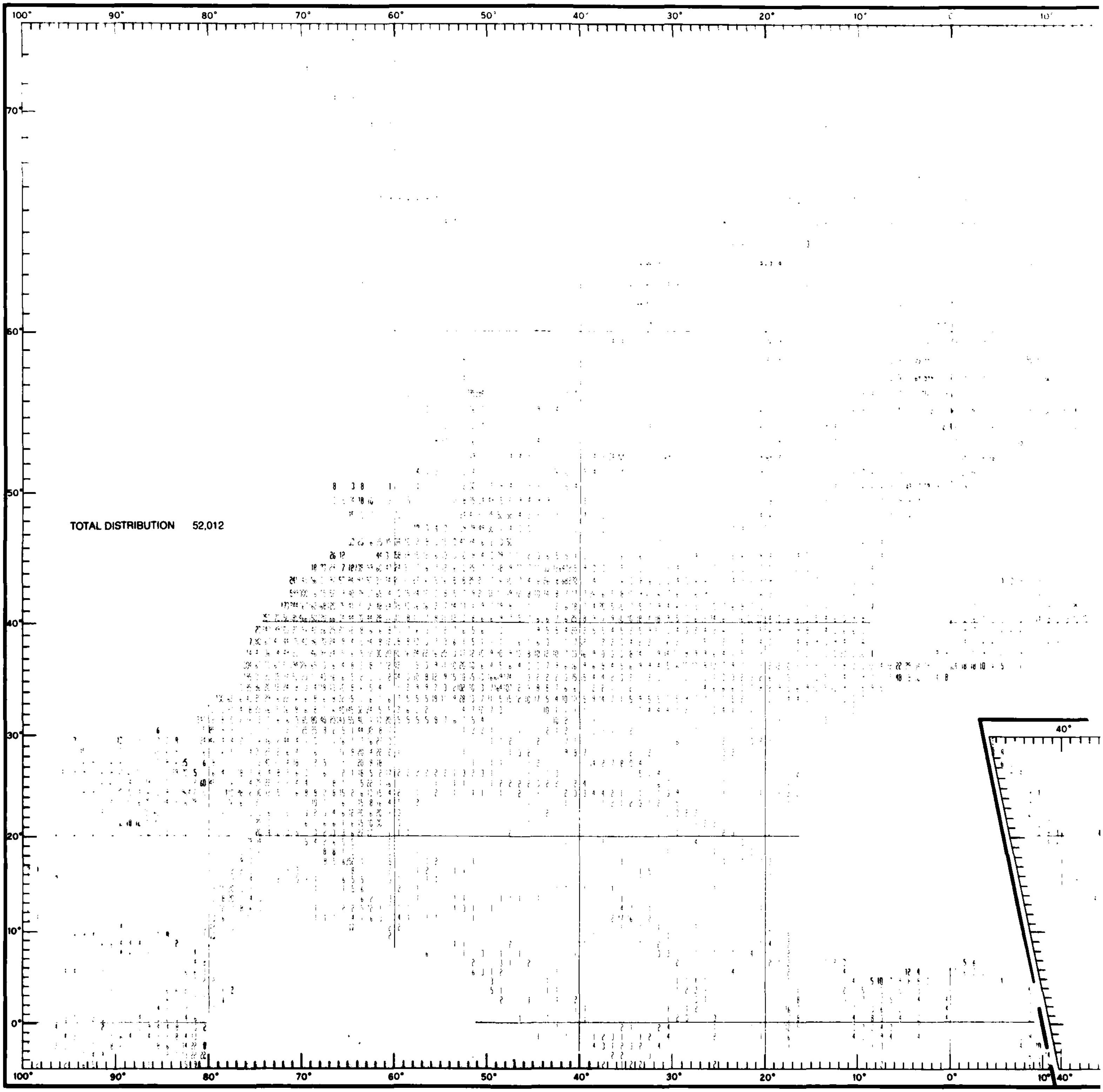
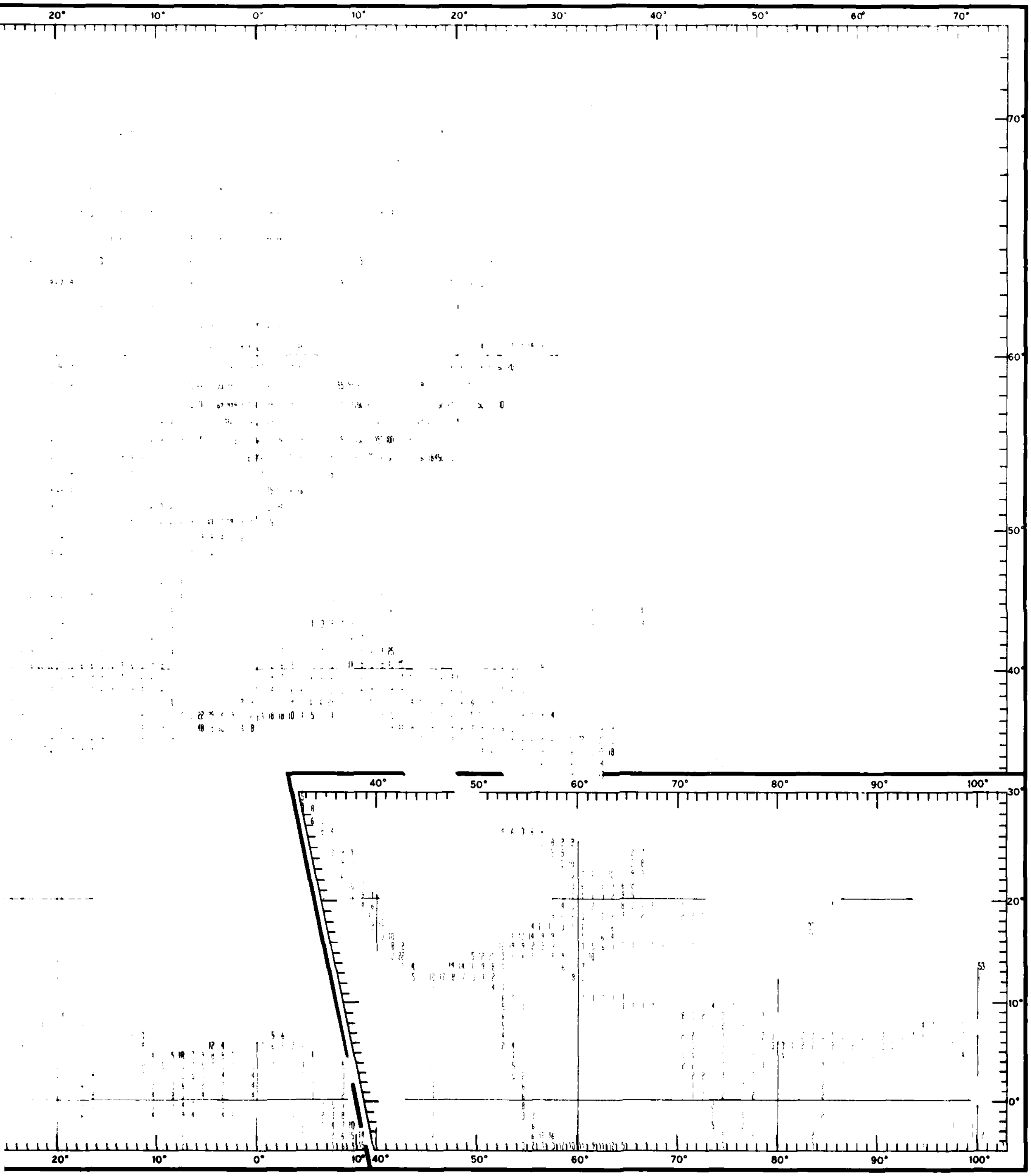


FIGURE 127. OCTOBER DATA DISTRIBUTION OF TEMPERATURES AT THE SURFACE



ATA DISTRIBUTION OF TEMPERATURES AT THE SURFACE

1 2

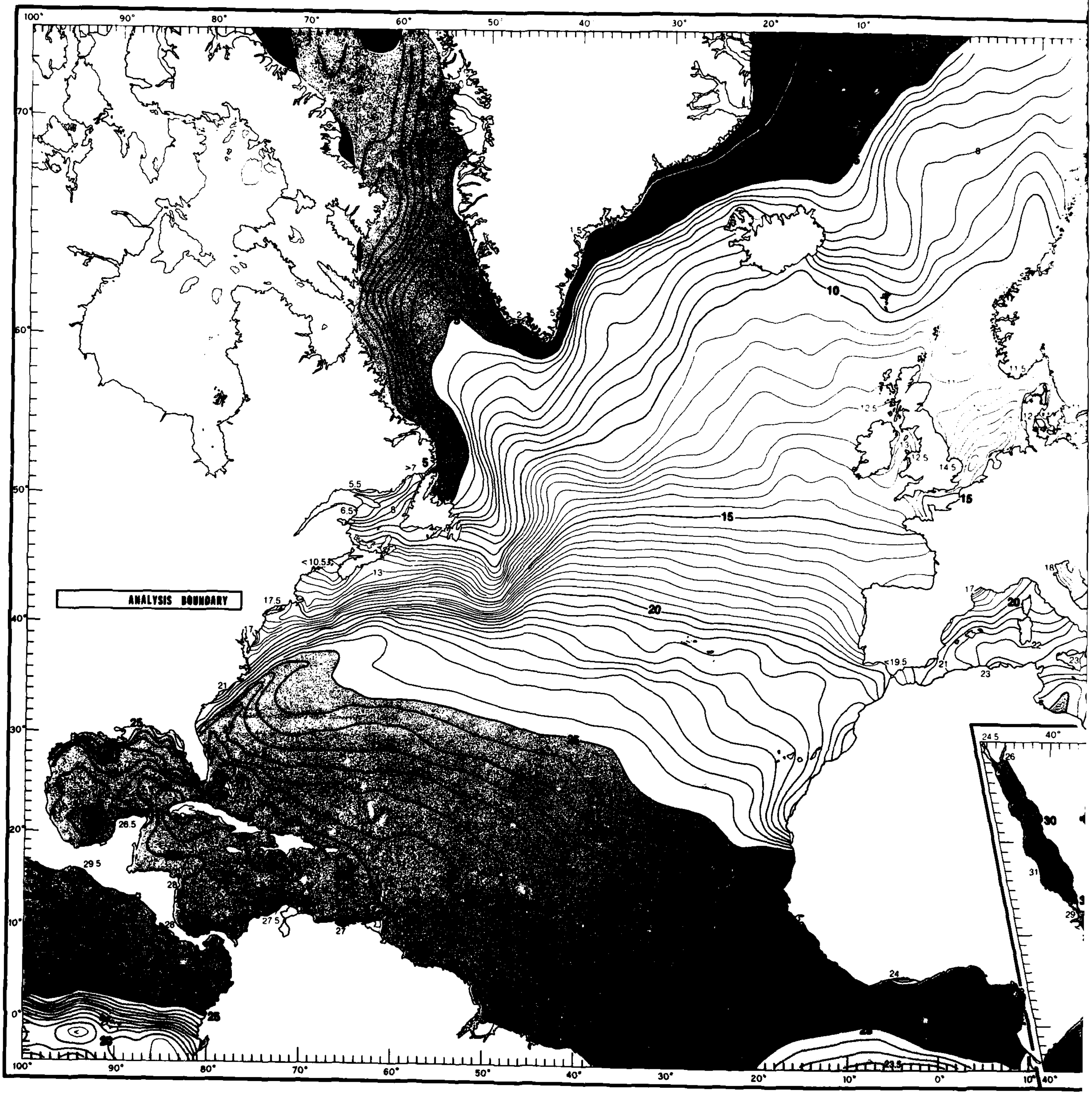
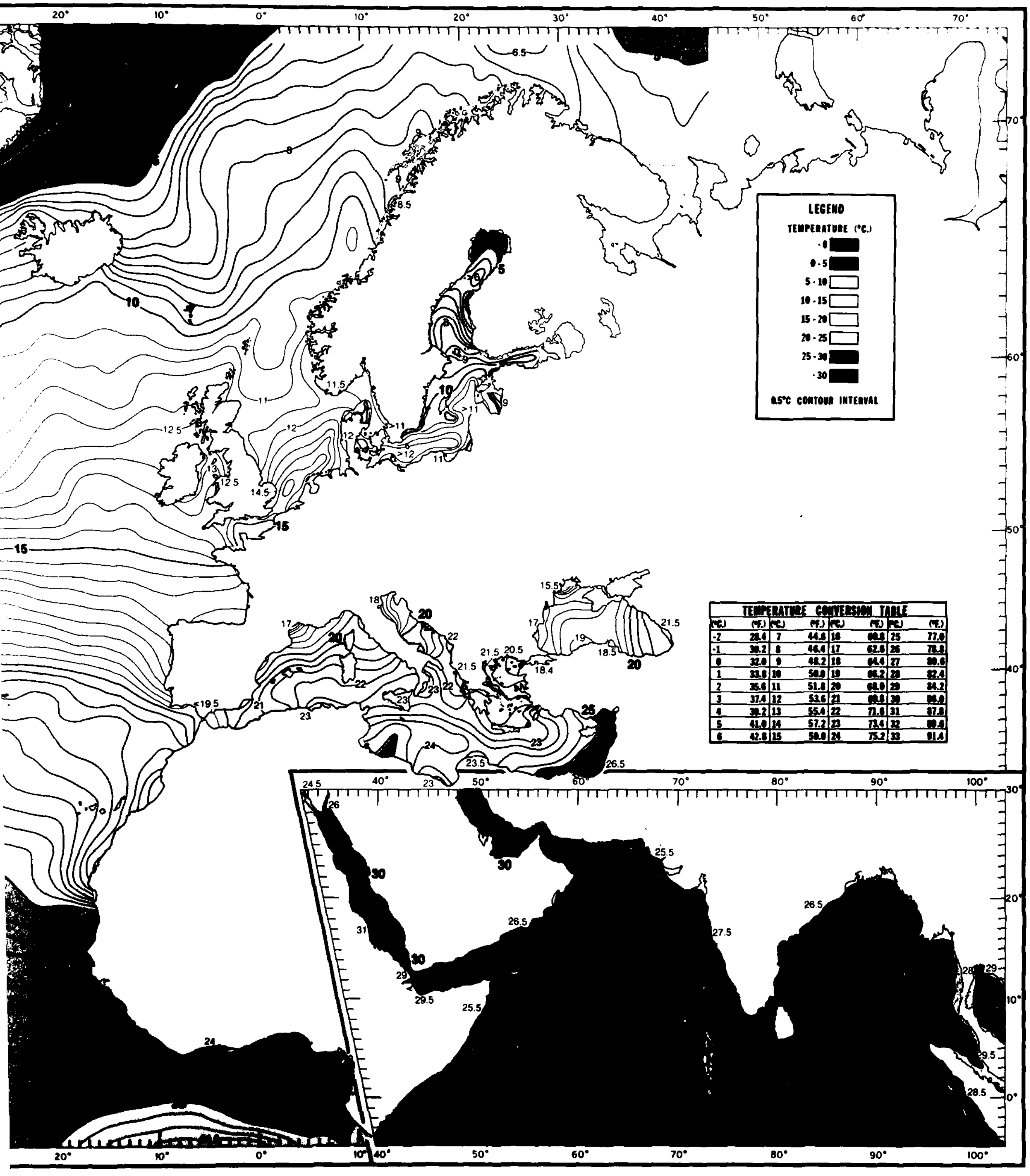


FIGURE 128. OCTOBER MEAN TEMPERATURES AT THE SURFACE



TEMPERATURE CONVERSION TABLE							
(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

R MEAN TEMPERATURES AT THE SURFACE

1 2

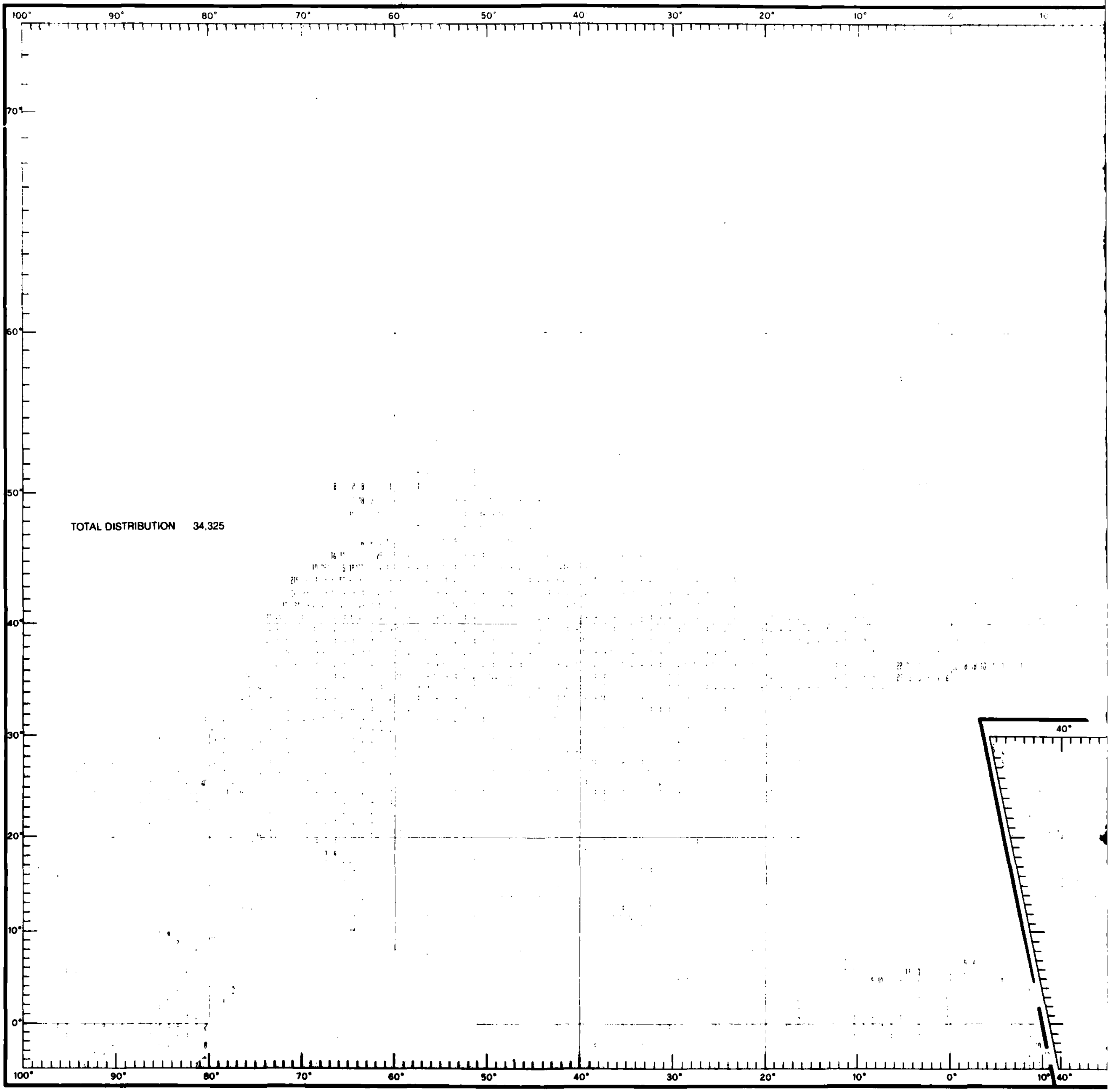
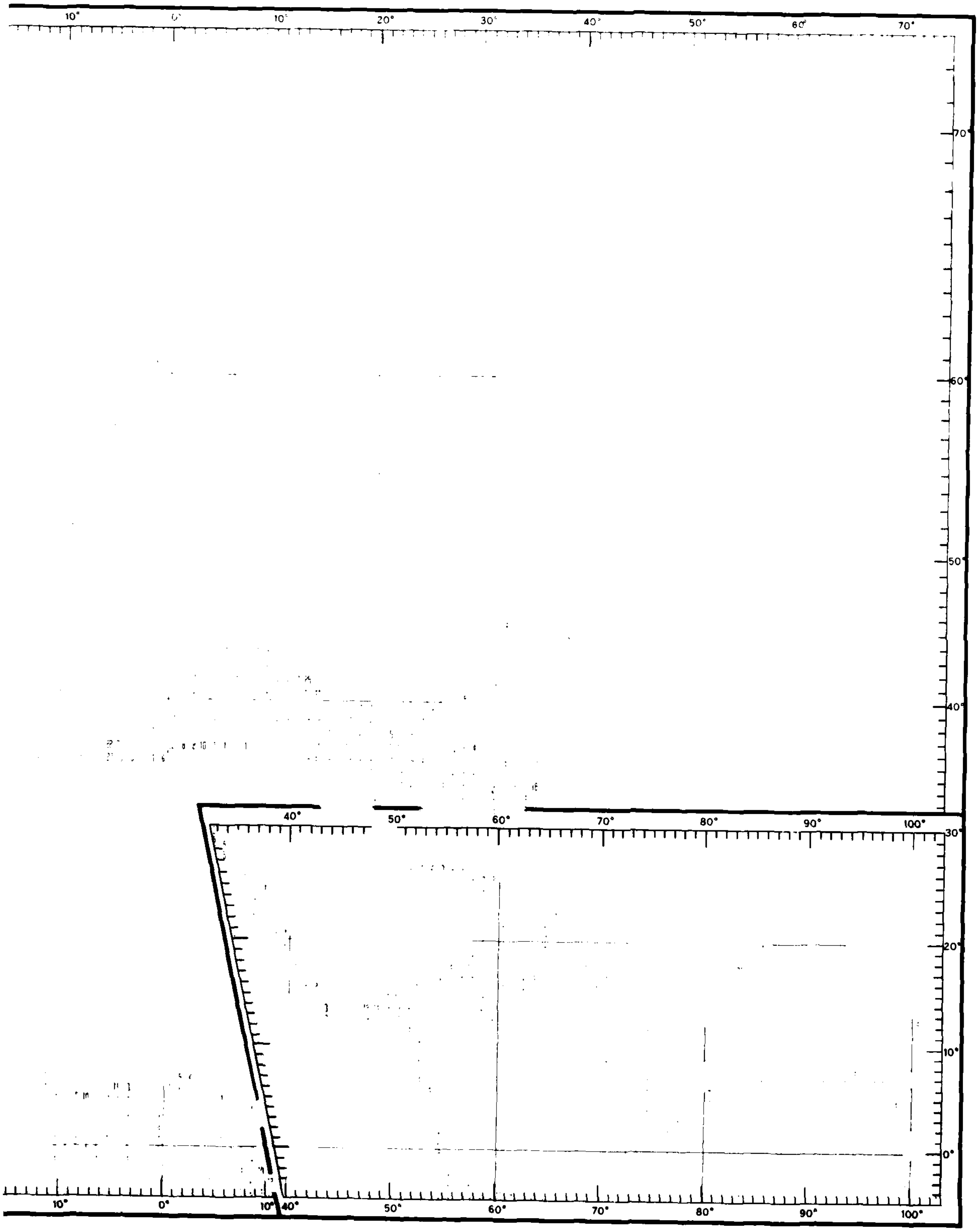


FIGURE 129. OCTOBER DATA DISTRIBUTION OF TEMPERATURES AT 100 FT (30 M)



ITION OF TEMPERATURES AT 100 FT (30 M)

1 2

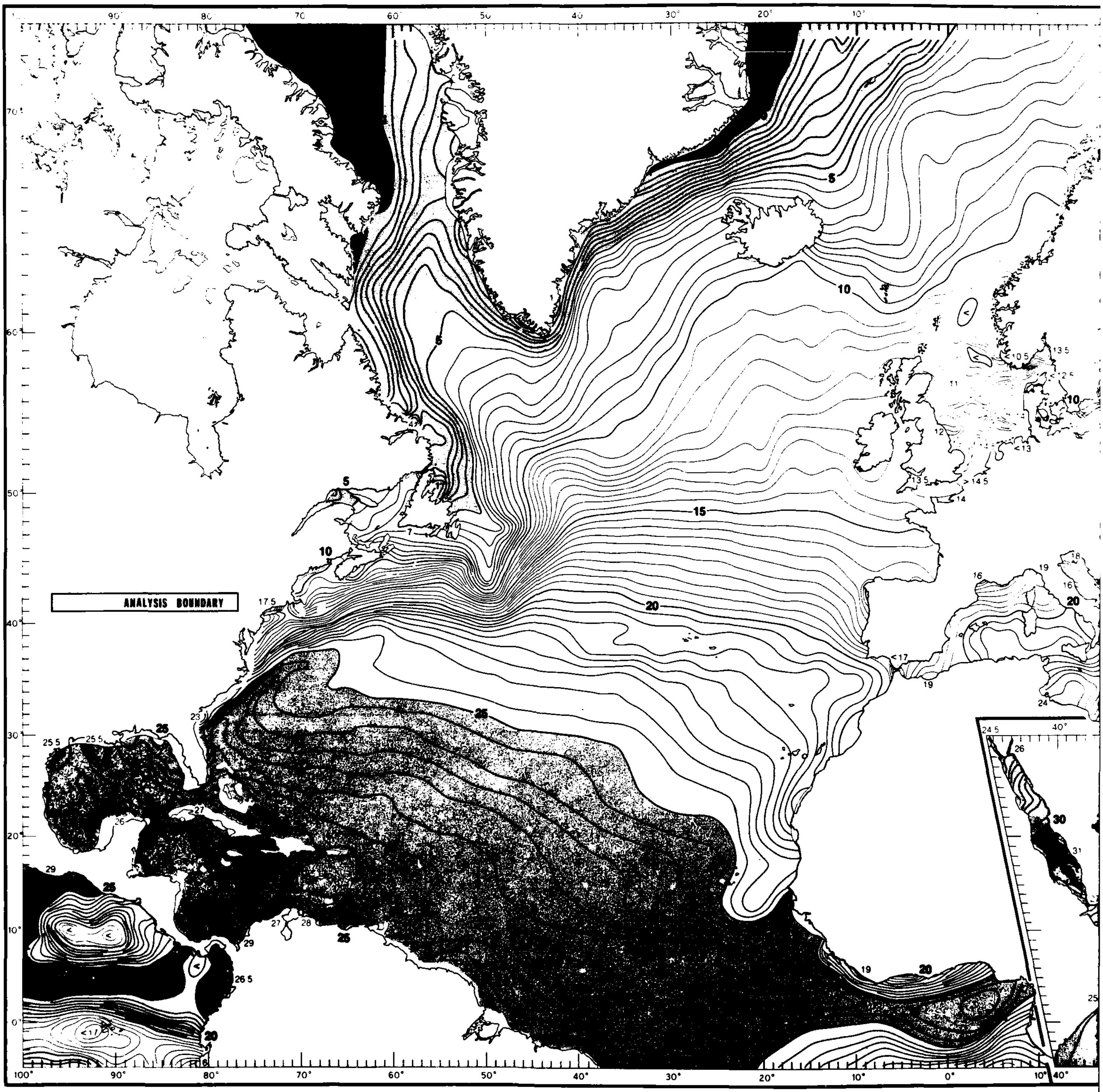
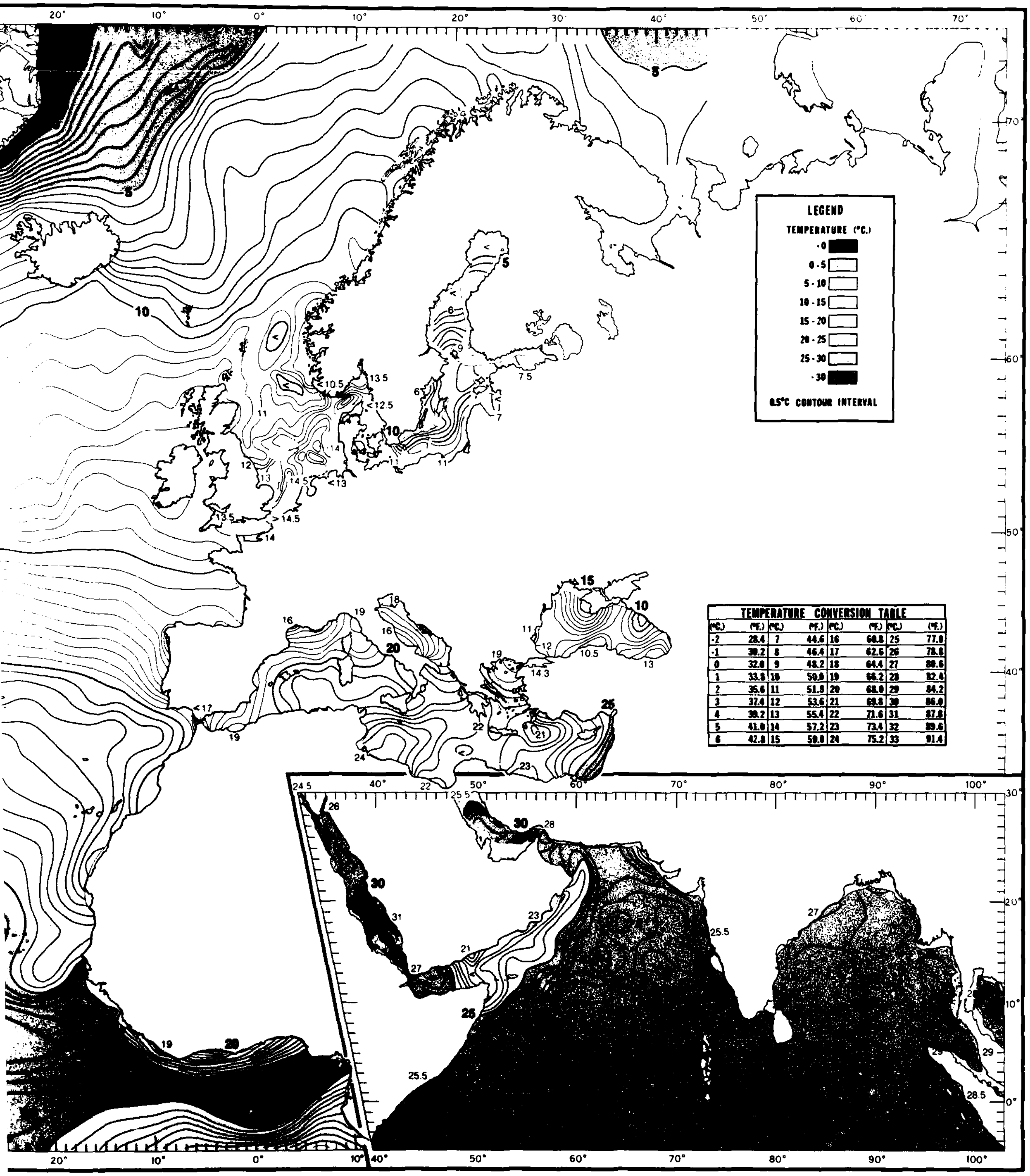


FIGURE 130. OCTOBER MEAN TEMPERATURES AT 100 FT (30 M)



TEMPERATURE CONVERSION TABLE							
(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

IER MEAN TEMPERATURES AT 100 FT (30 M)

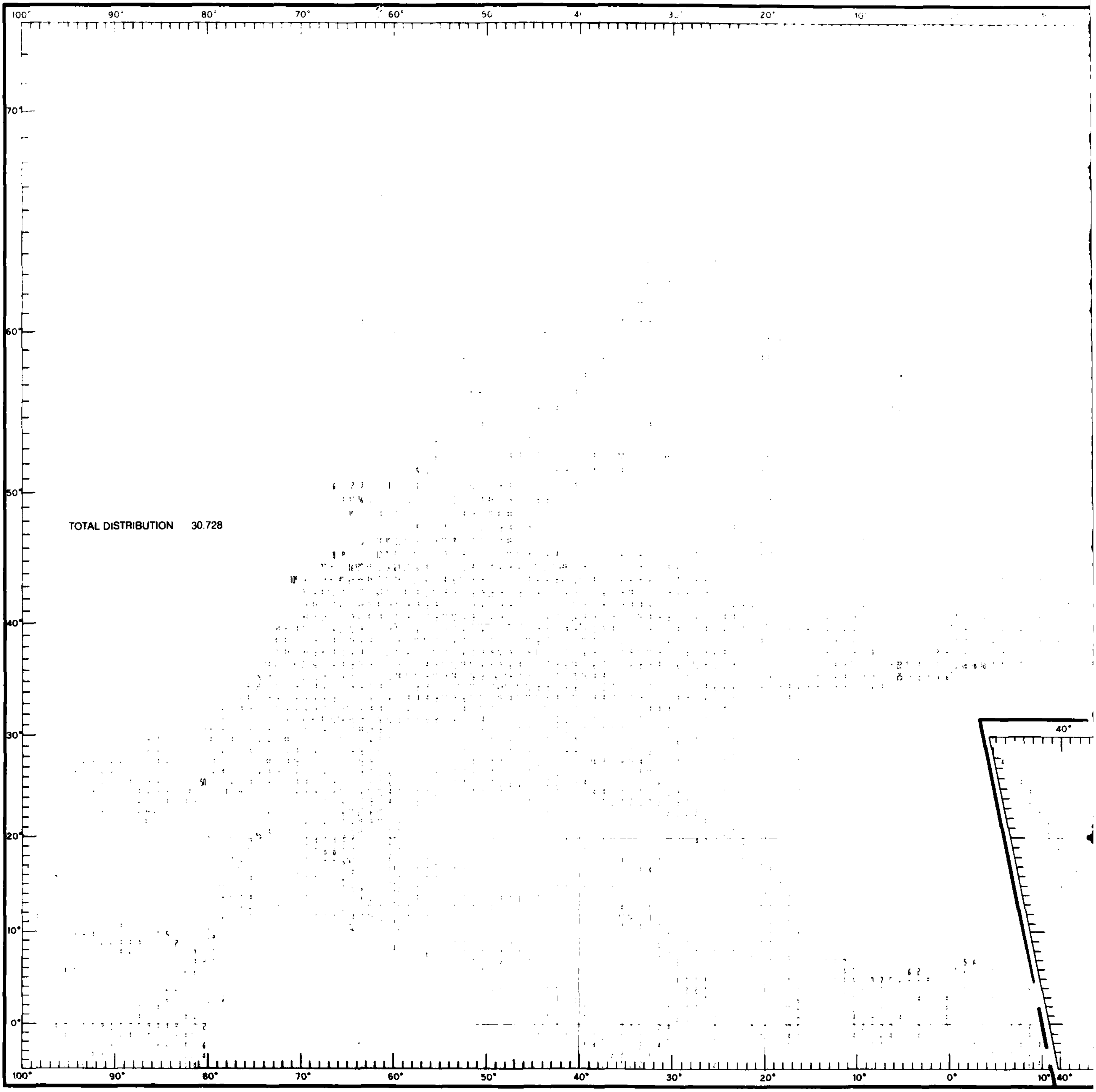
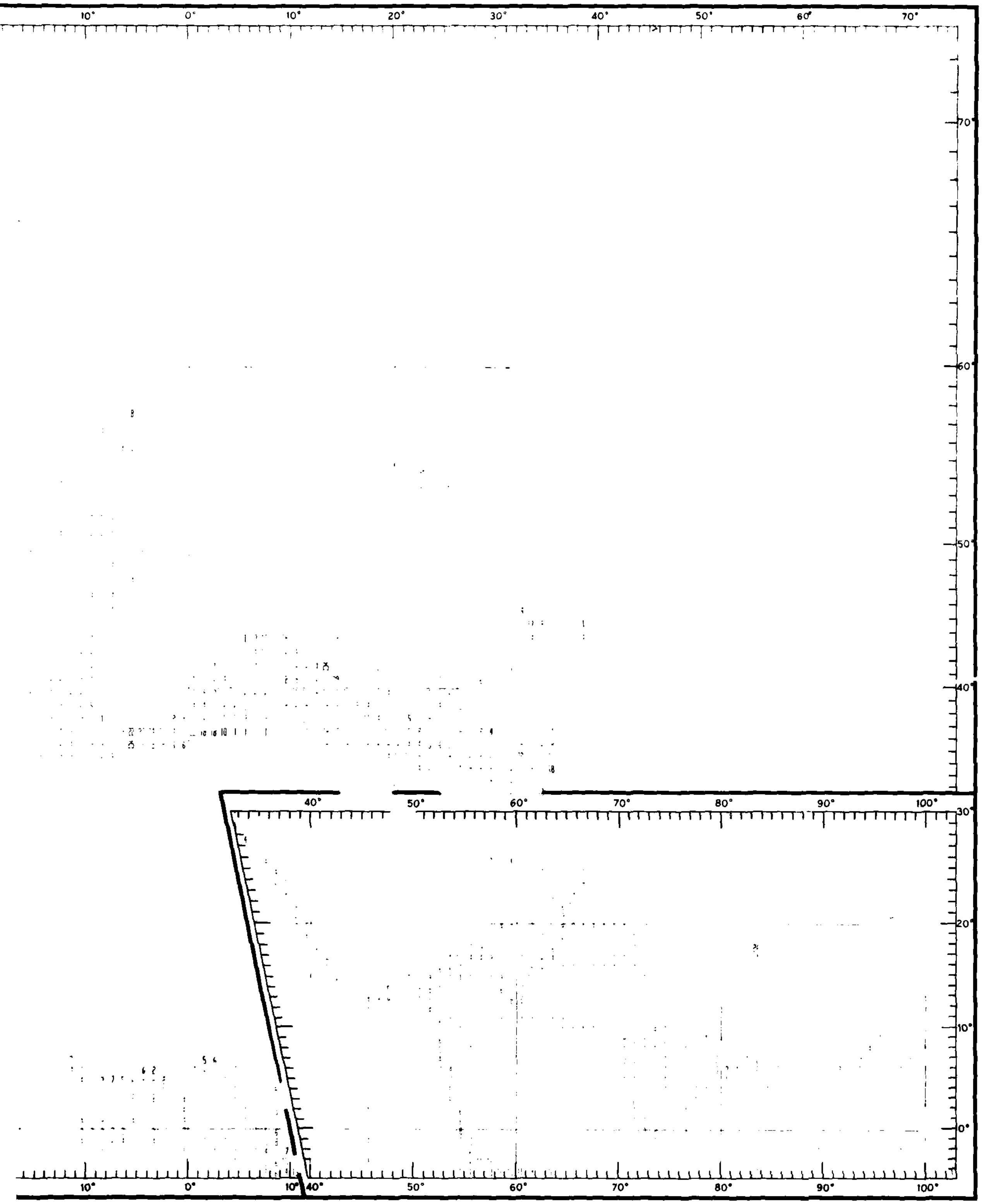


FIGURE 131. OCTOBER DATA DISTRIBUTION OF TEMPERATURES AT 200 FT (60 M



ɜUTION OF TEMPERATURES AT 200 FT (60 M)

1 2

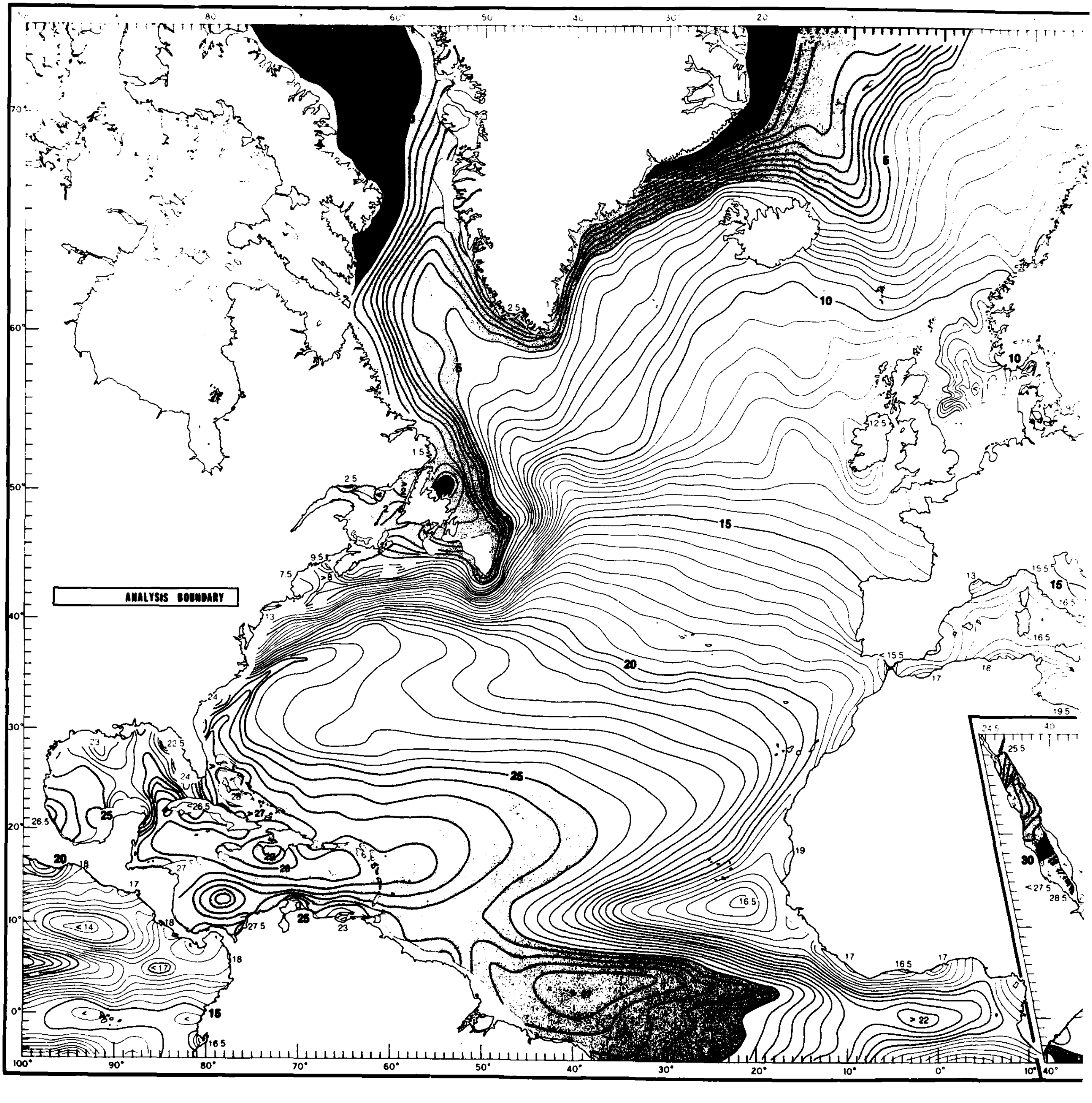
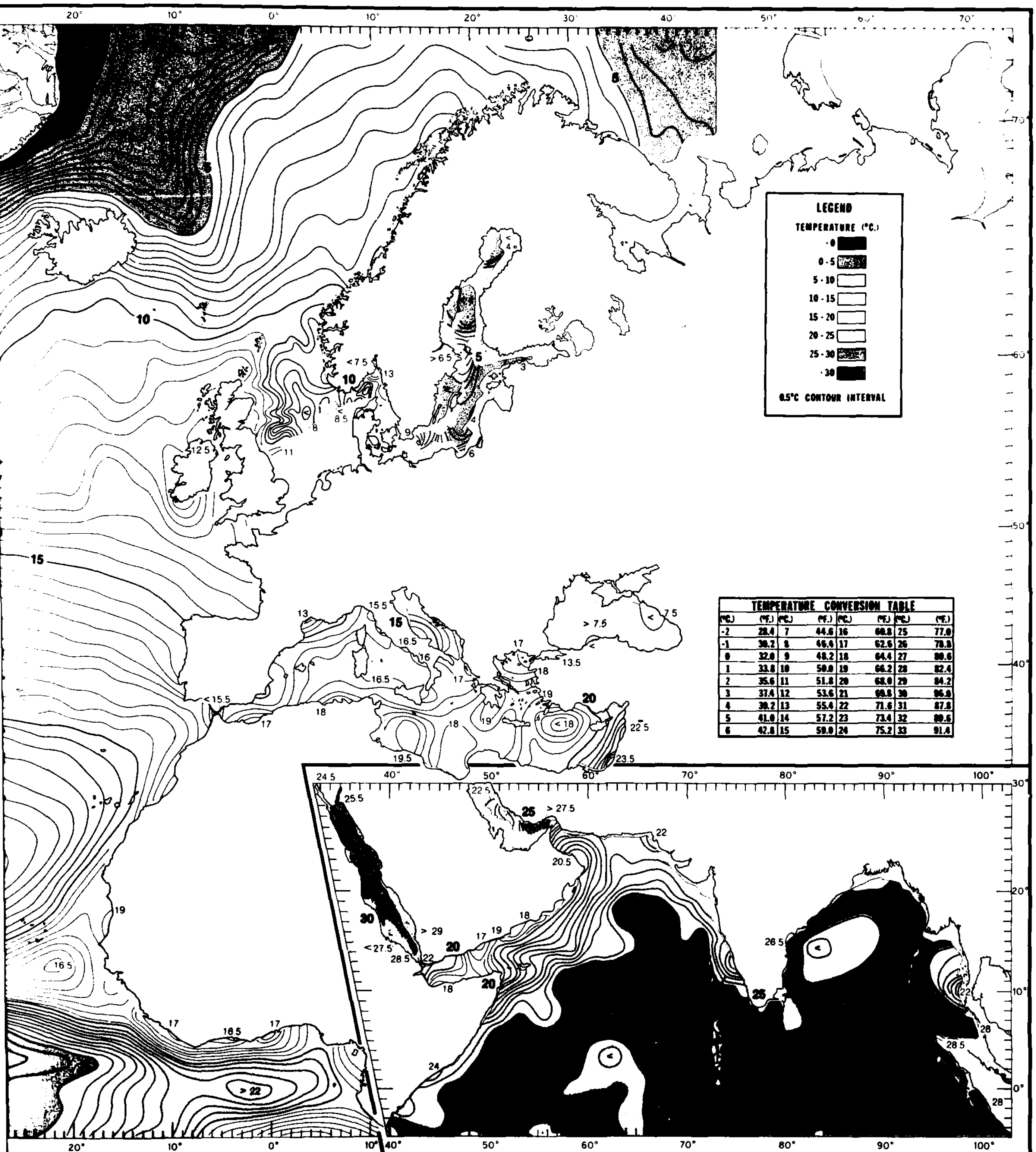


FIGURE 132. OCTOBER MEAN TEMPERATURES AT 200 FT (60 M)



TEMPERATURE CONVERSION TABLE

(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

OCTOBER MEAN TEMPERATURES AT 200 FT (60 M)

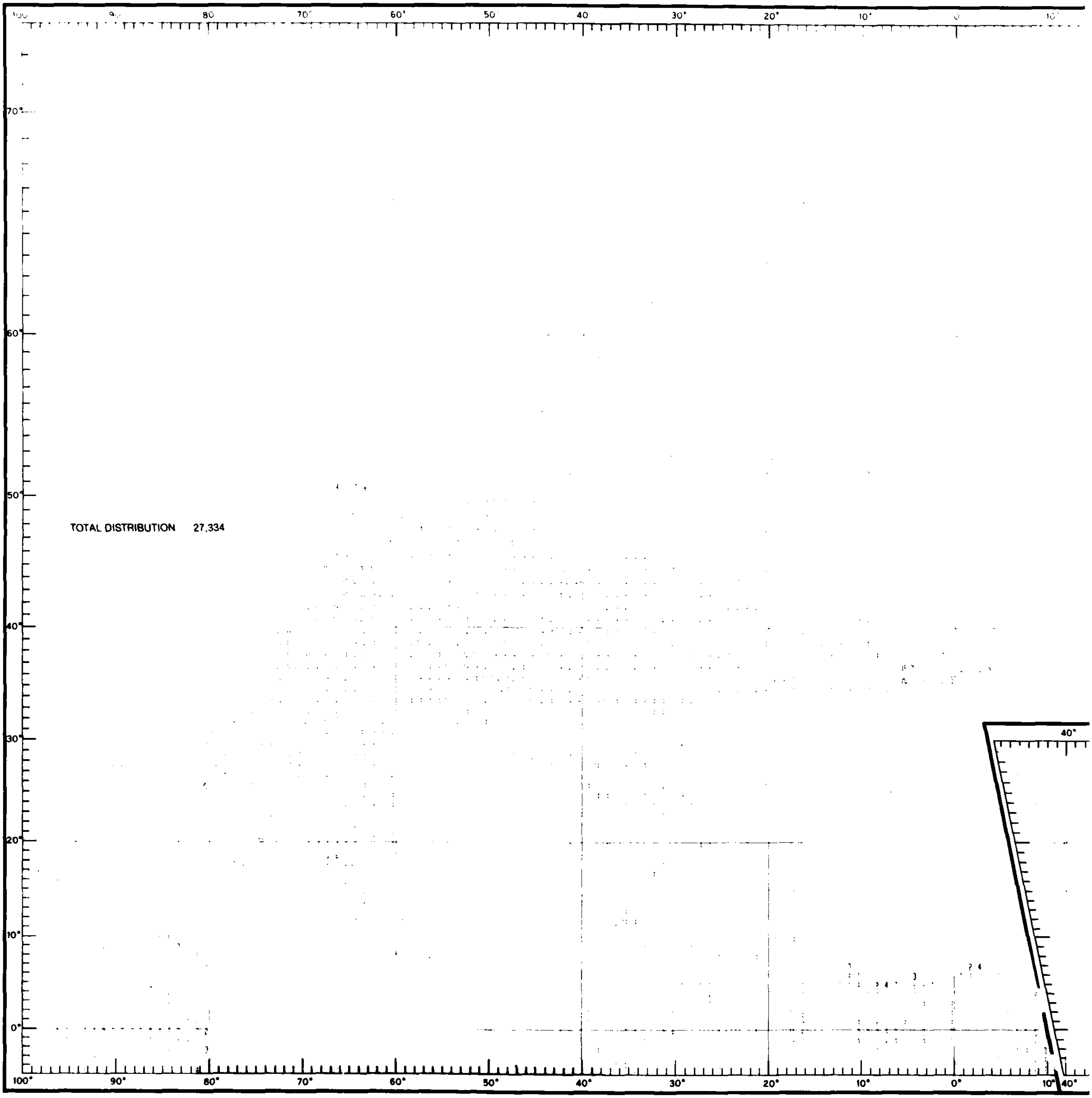
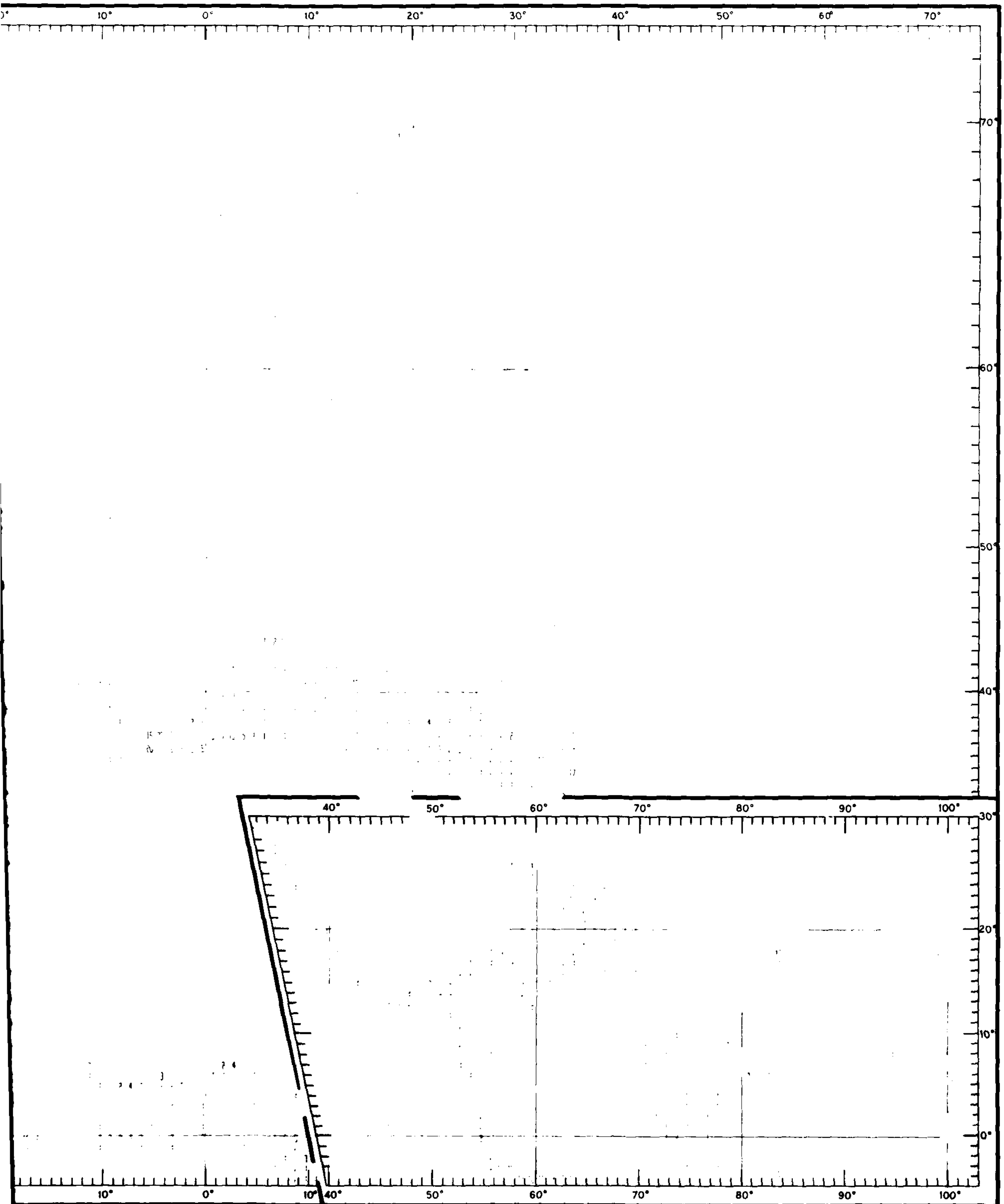


FIGURE 133. OCTOBER DATA DISTRIBUTION OF TEMPERATURES AT 300 FT (90



RIBUTION OF TEMPERATURES AT 300 FT (90 M)

1 2

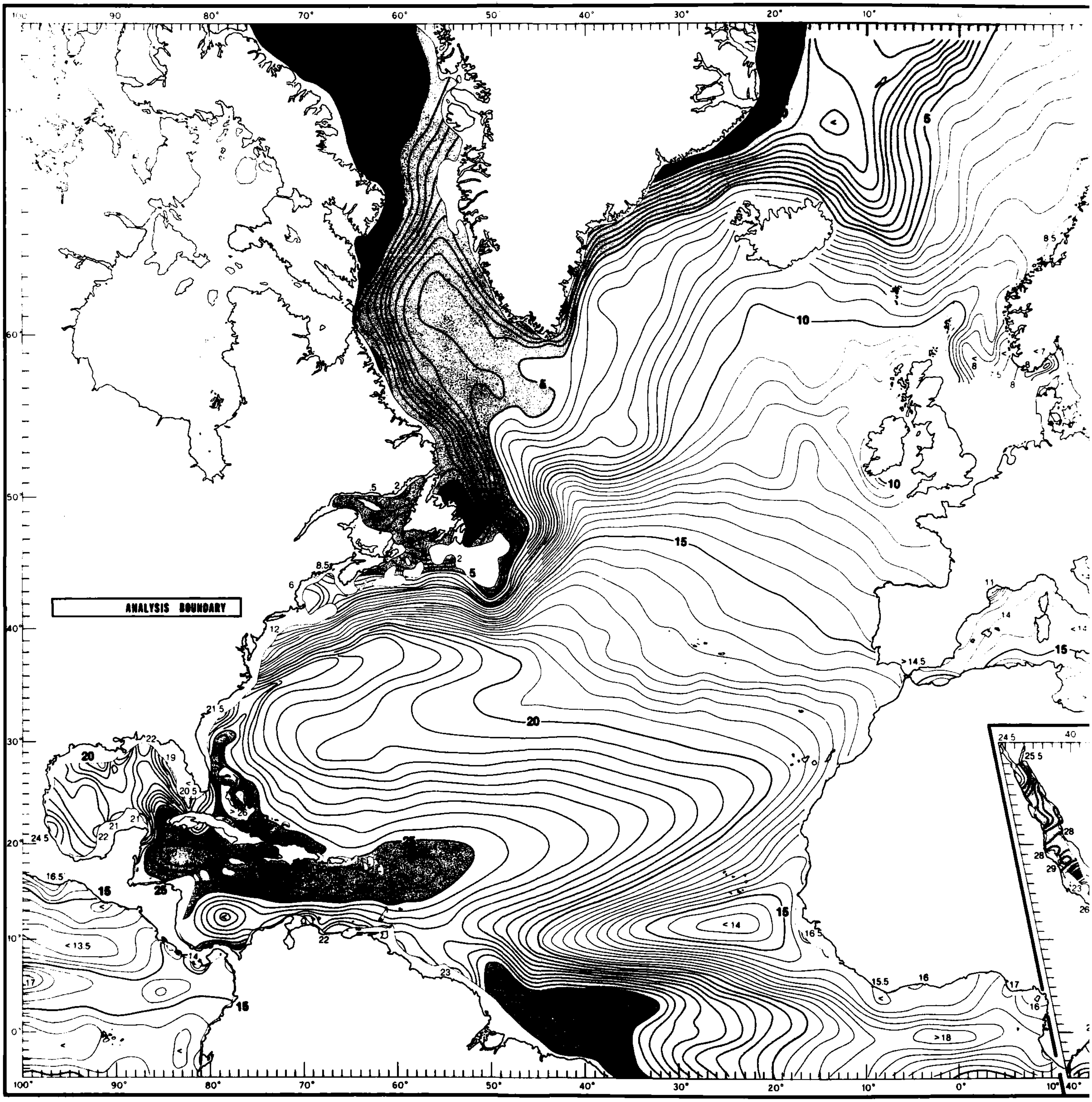
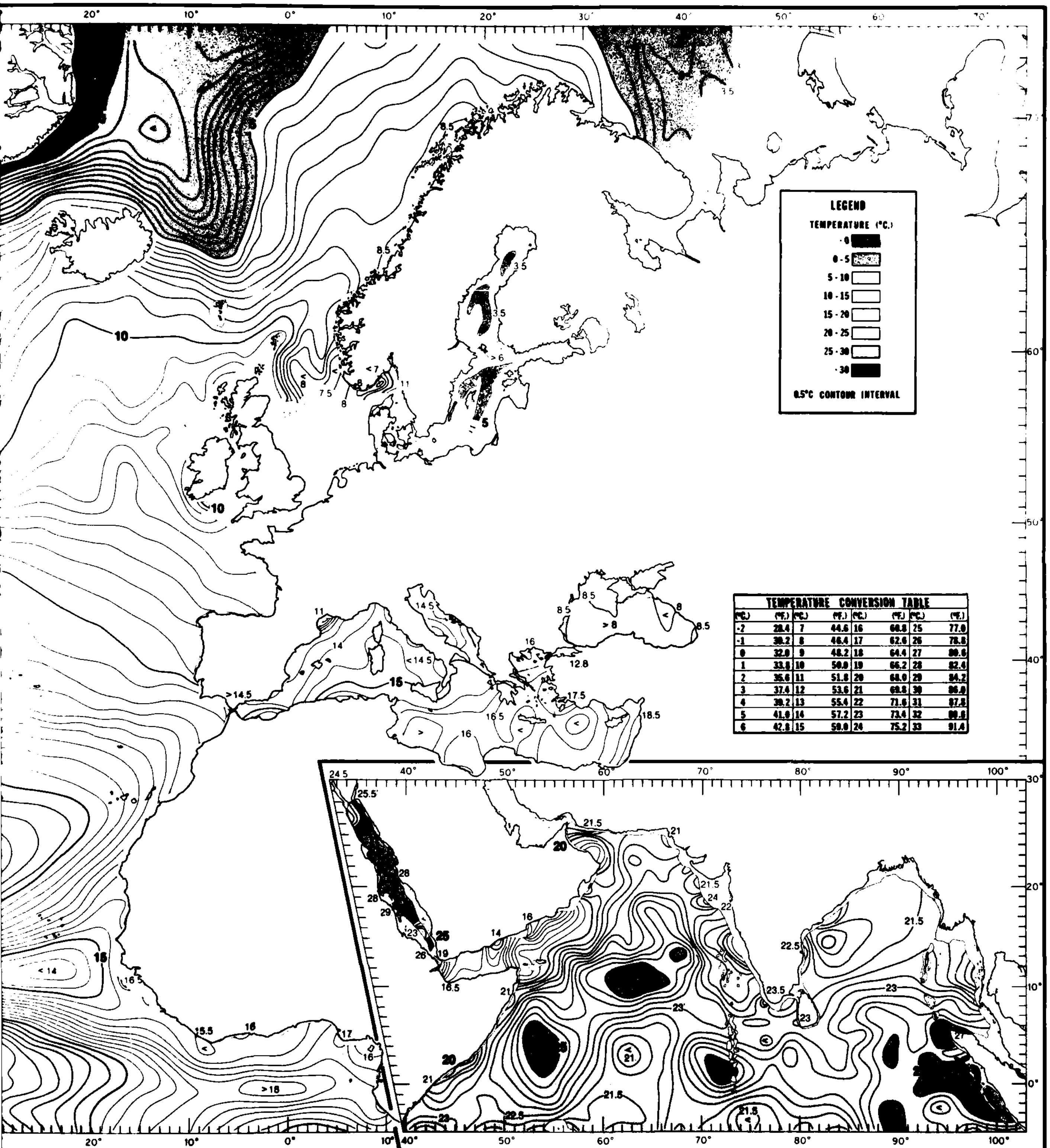


FIGURE 134. OCTOBER MEAN TEMPERATURES AT 300 FT (90 M)



(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

OCTOBER MEAN TEMPERATURES AT 300 FT (90 M)

2

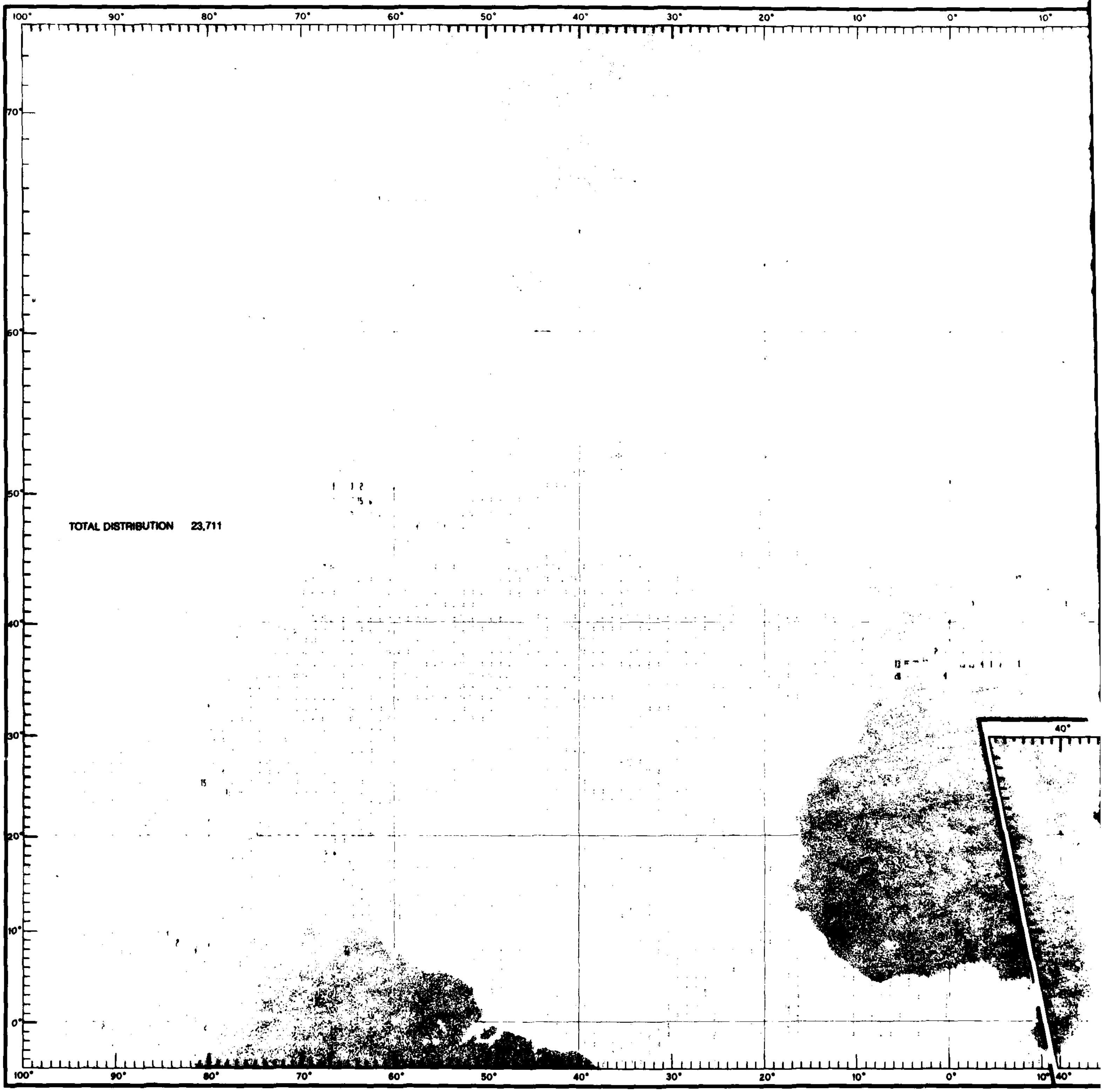
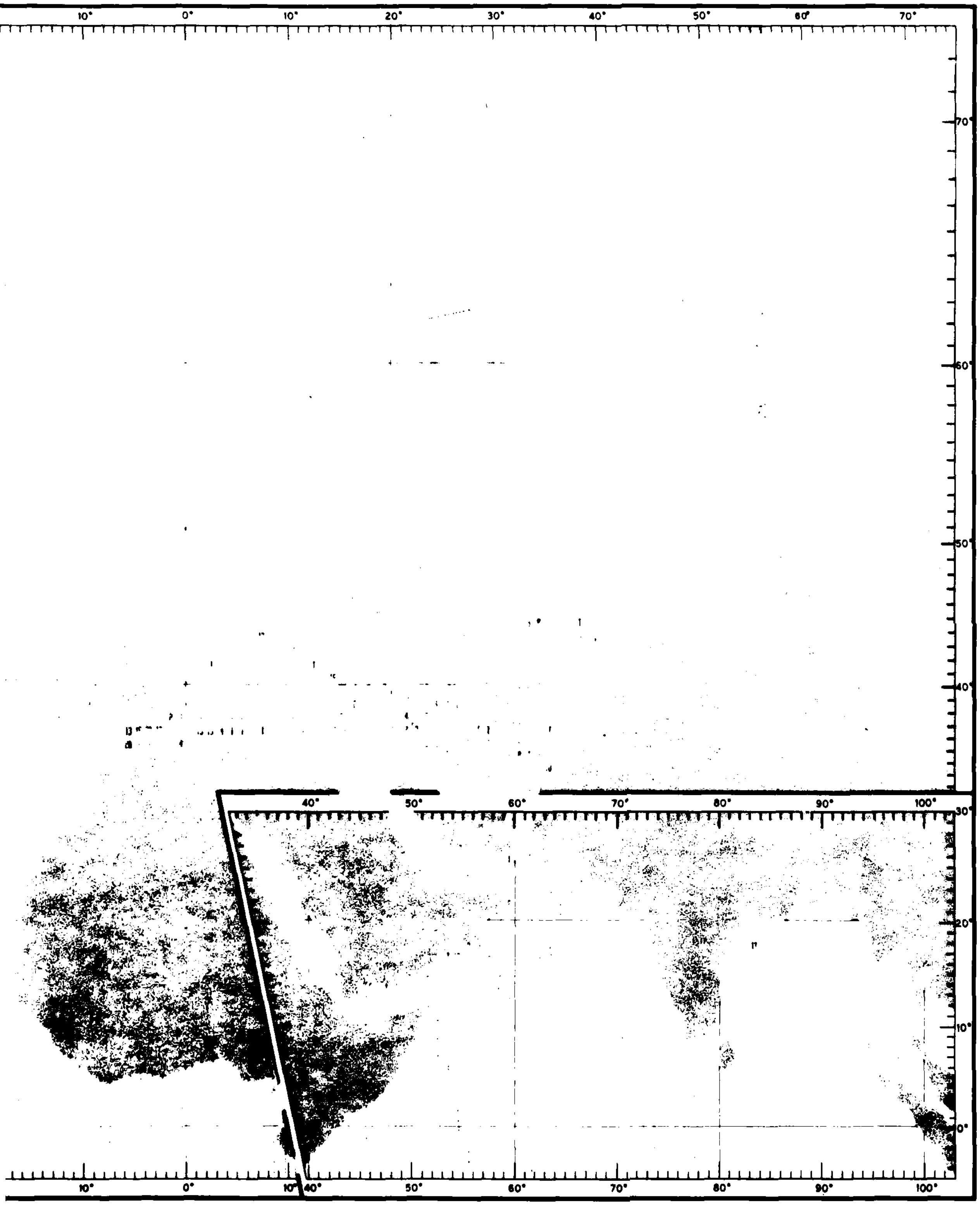


FIGURE 135. OCTOBER DATA DISTRIBUTION OF TEMPERATURES AT 400 FT (120 M



IBUTION OF TEMPERATURES AT 400 FT (120 M)

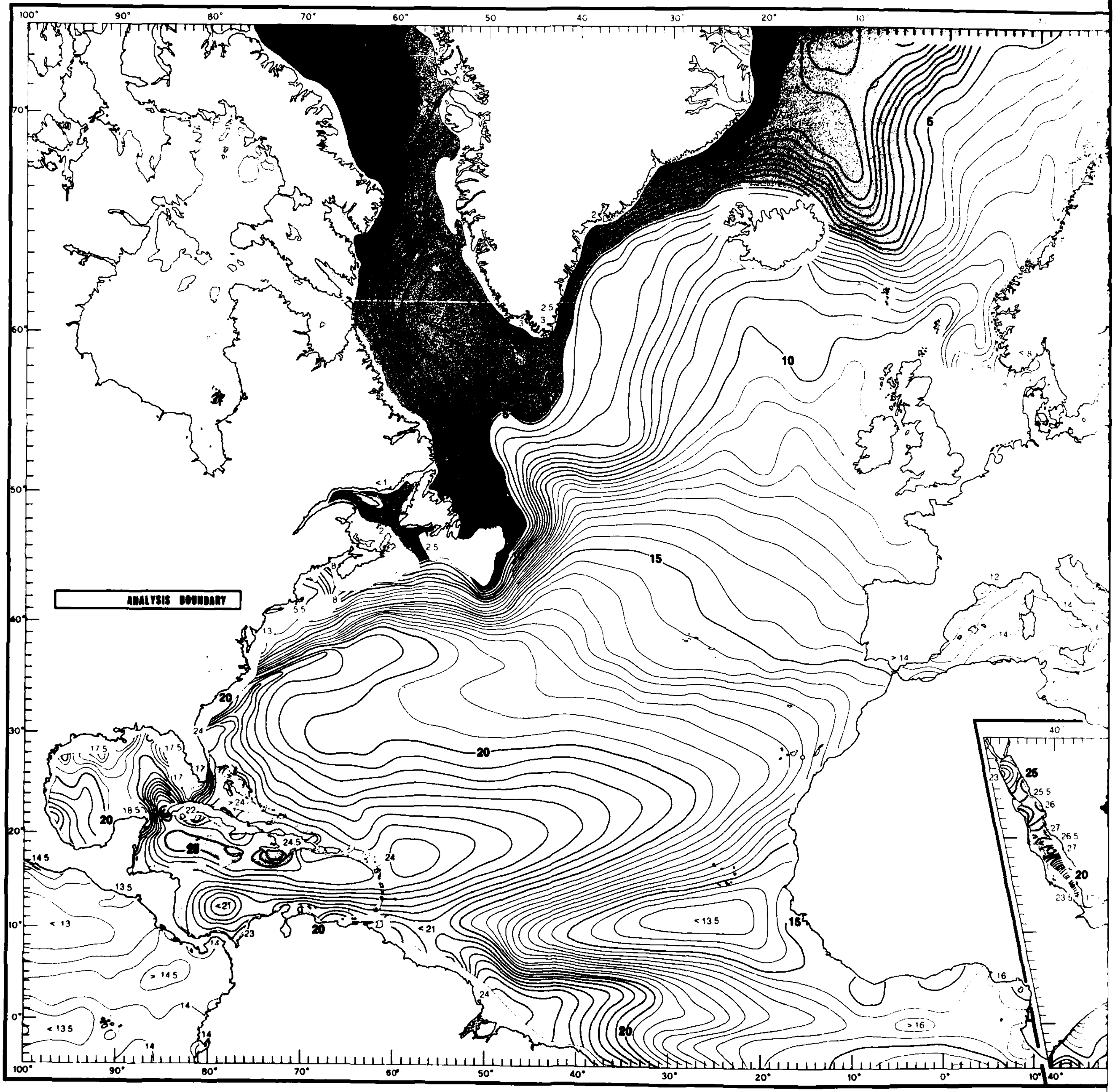
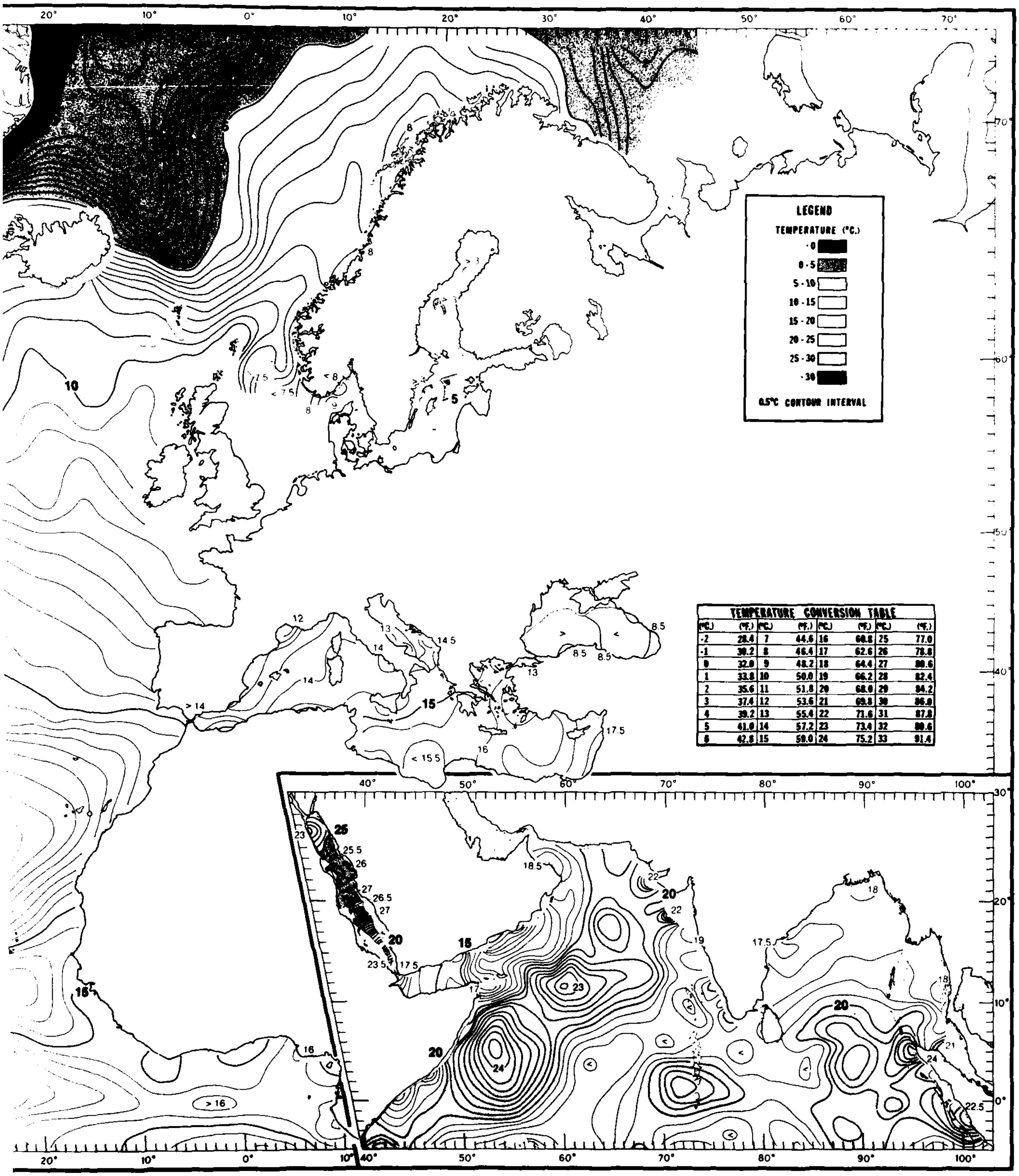


FIGURE 136. OCTOBER MEAN TEMPERATURES AT 400 FT (120 M)



TEMPERATURE CONVERSION TABLE							
(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

MEAN TEMPERATURES AT 400 FT (120 M)

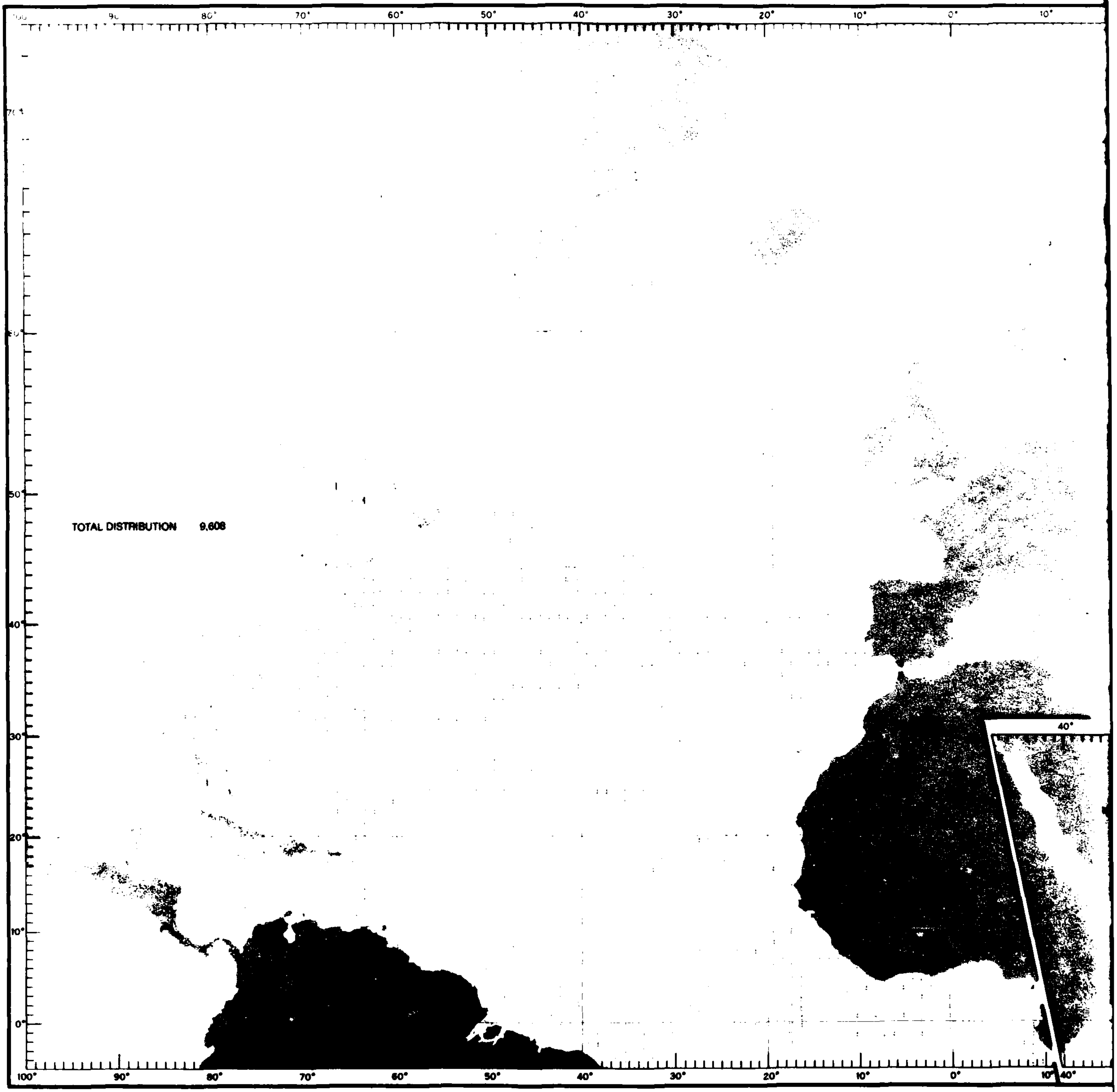


FIGURE 137. OCTOBER DATA DISTRIBUTION OF TEMPERATURES AT 492 FT (150 M)

BUTION OF TEMPERATURES AT 492 FT (150 M)

1 2

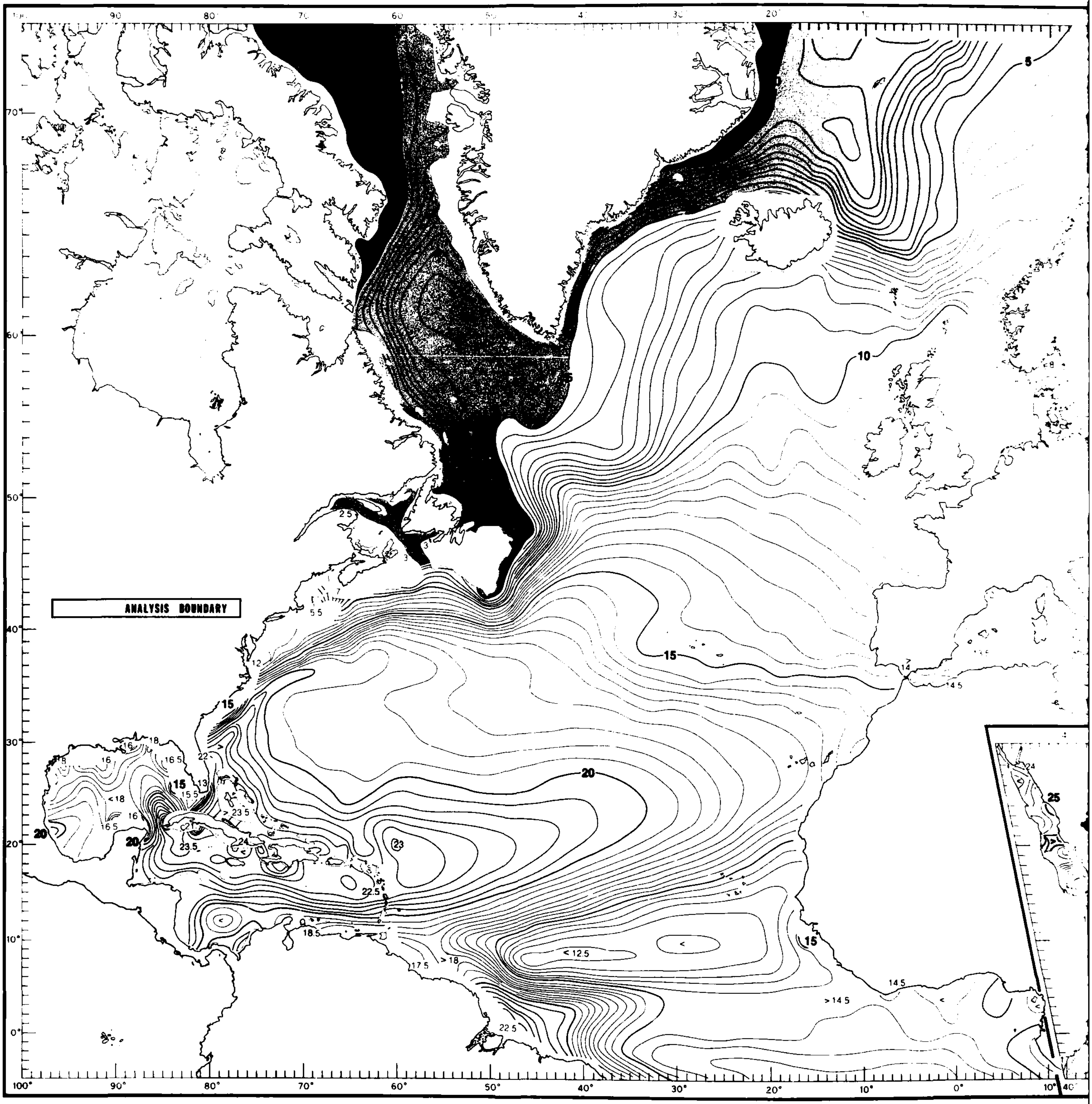
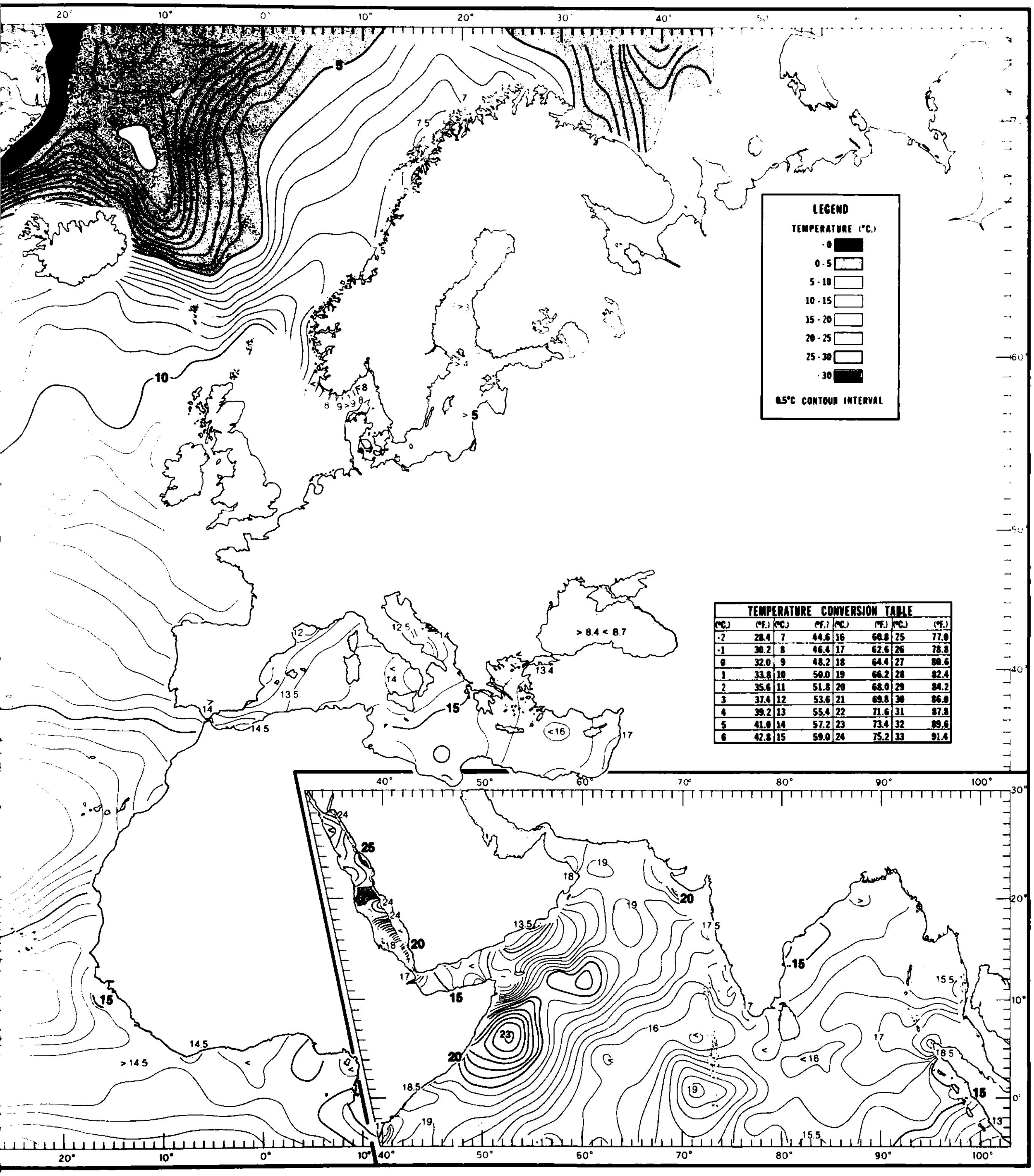


FIGURE 138. OCTOBER MEAN TEMPERATURES AT 492 FT (150 M)



TEMPERATURE CONVERSION TABLE							
(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

TOBER MEAN TEMPERATURES AT 492 FT (150 M)

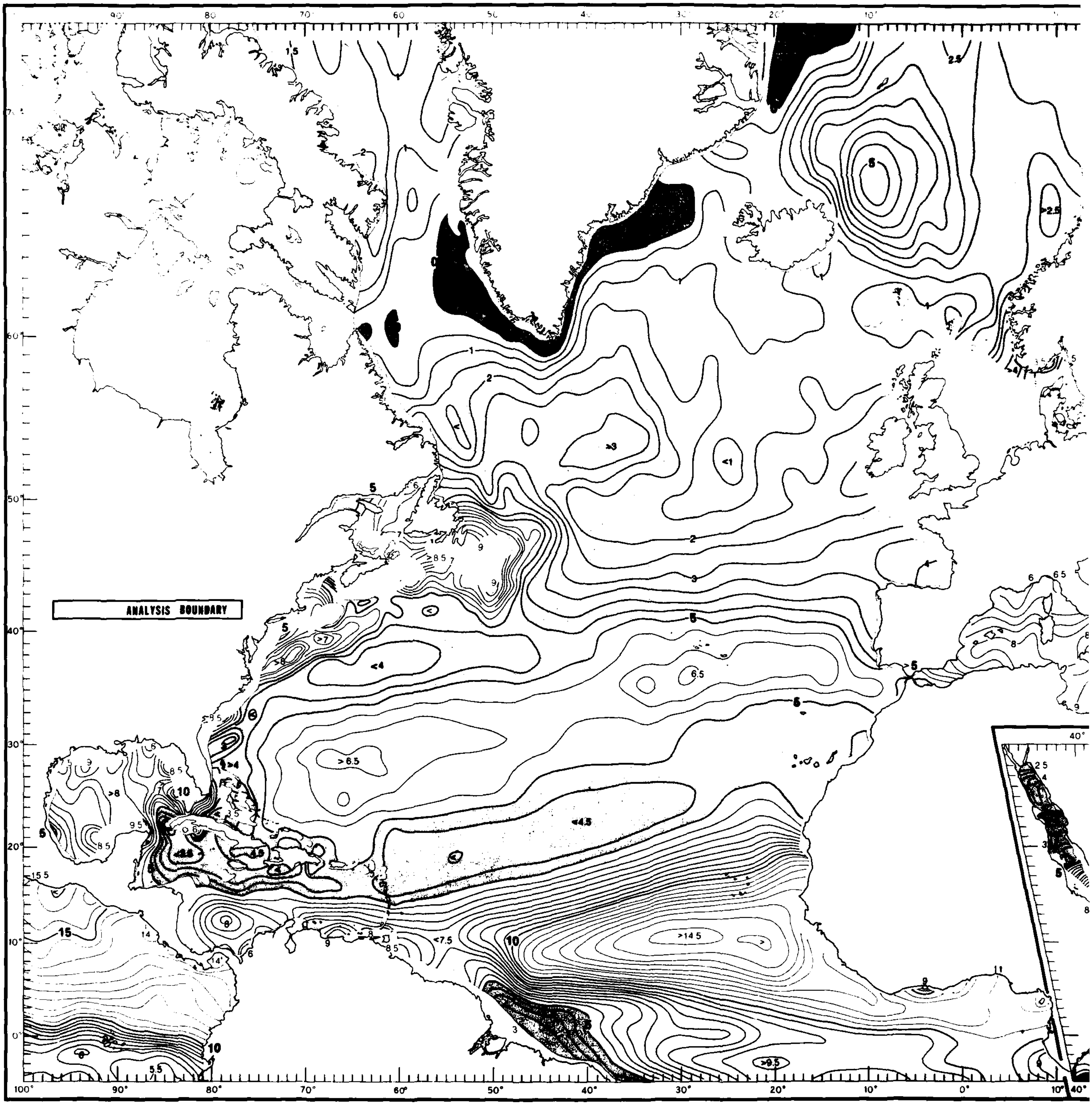
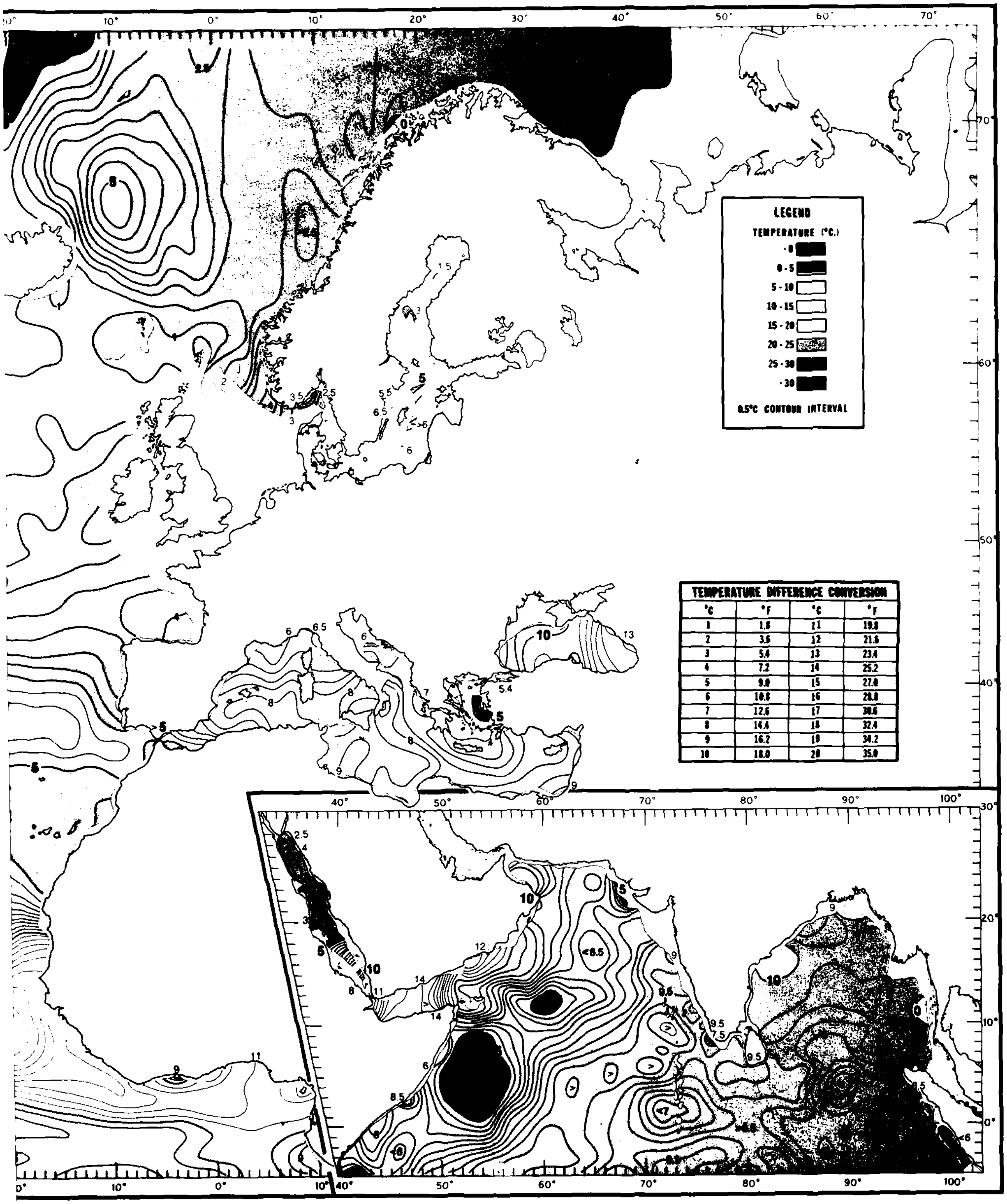


FIGURE 139. OCTOBER TEMPERATURE DIFFERENCE BETWEEN THE SURFACE AND 400 F



TEMPERATURE DIFFERENCE CONVERSION			
°C	°F	°C	°F
1	1.8	11	19.8
2	3.6	12	21.6
3	5.4	13	23.4
4	7.2	14	25.2
5	9.0	15	27.0
6	10.8	16	28.8
7	12.6	17	30.6
8	14.4	18	32.4
9	16.2	19	34.2
10	18.0	20	35.0

FERENCE BETWEEN THE SURFACE AND 400 FT (T_0-T_{400})

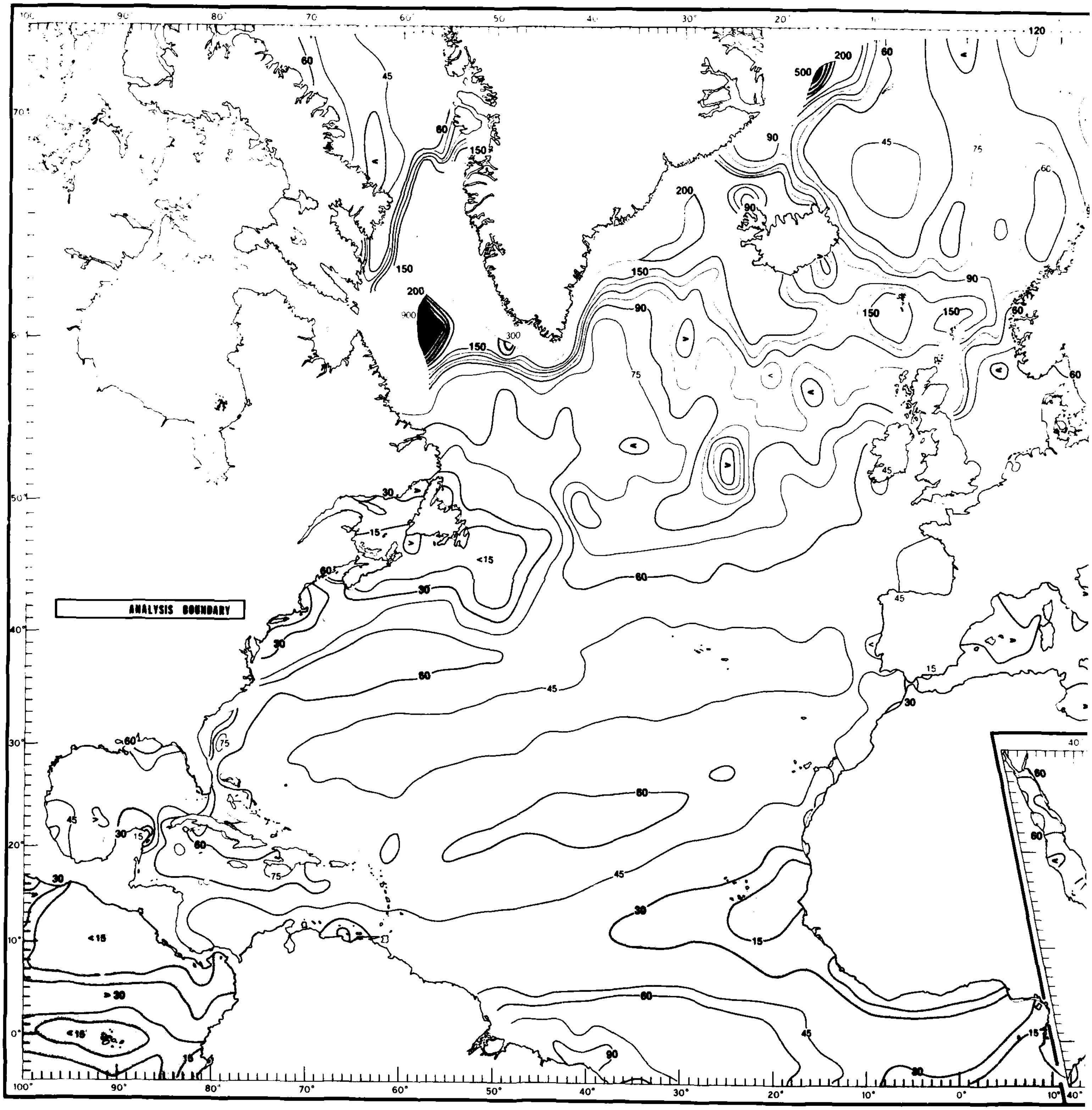
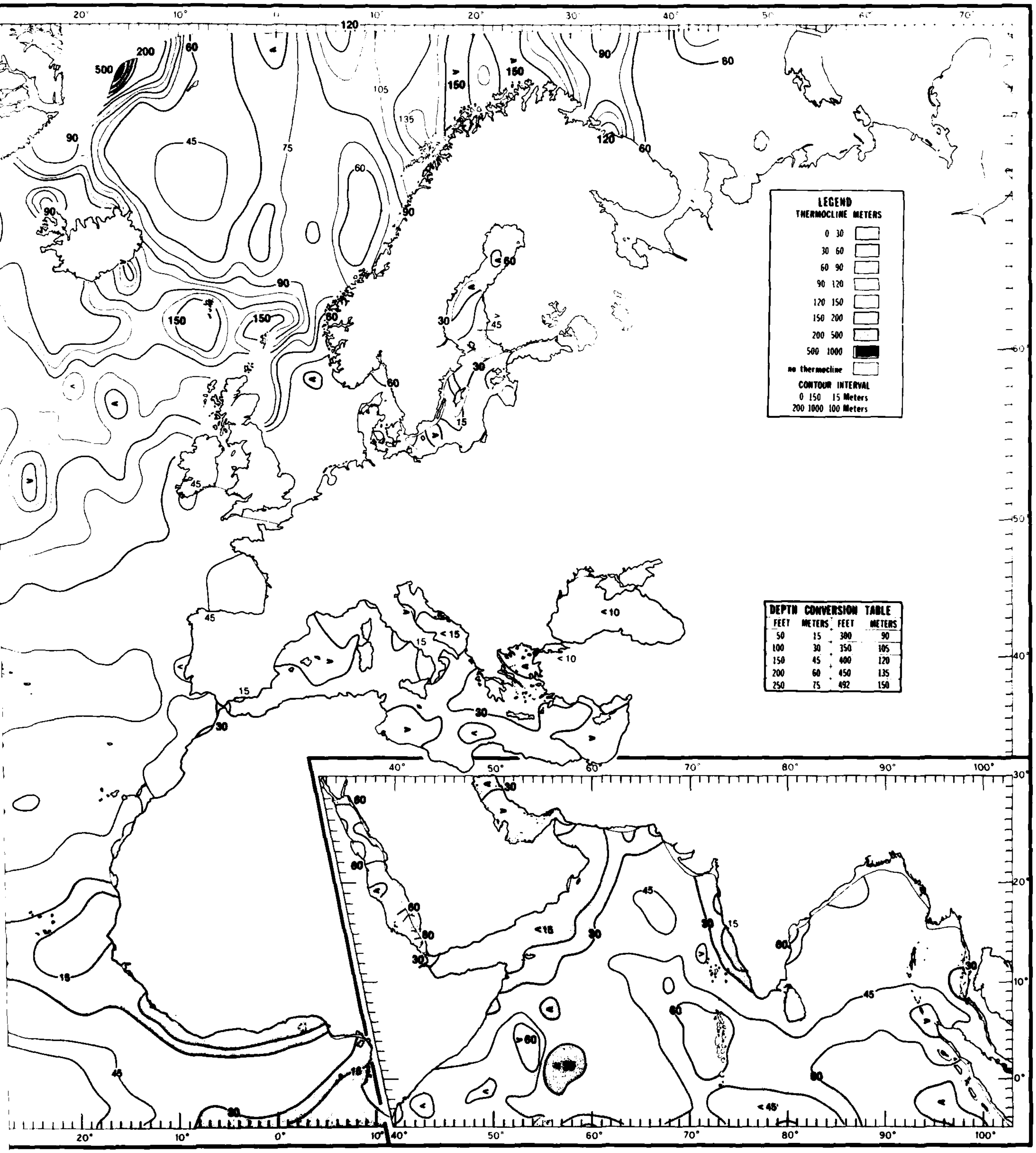


FIGURE 140. OCTOBER MEAN DEPTHS TO THE TOP OF THE THERMOCLIN



FEET	METERS	FEET	METERS
50	15	300	90
100	30	350	105
150	45	400	120
200	60	450	135
250	75	492	150

BER MEAN DEPTHS TO THE TOP OF THE THERMOCLINE

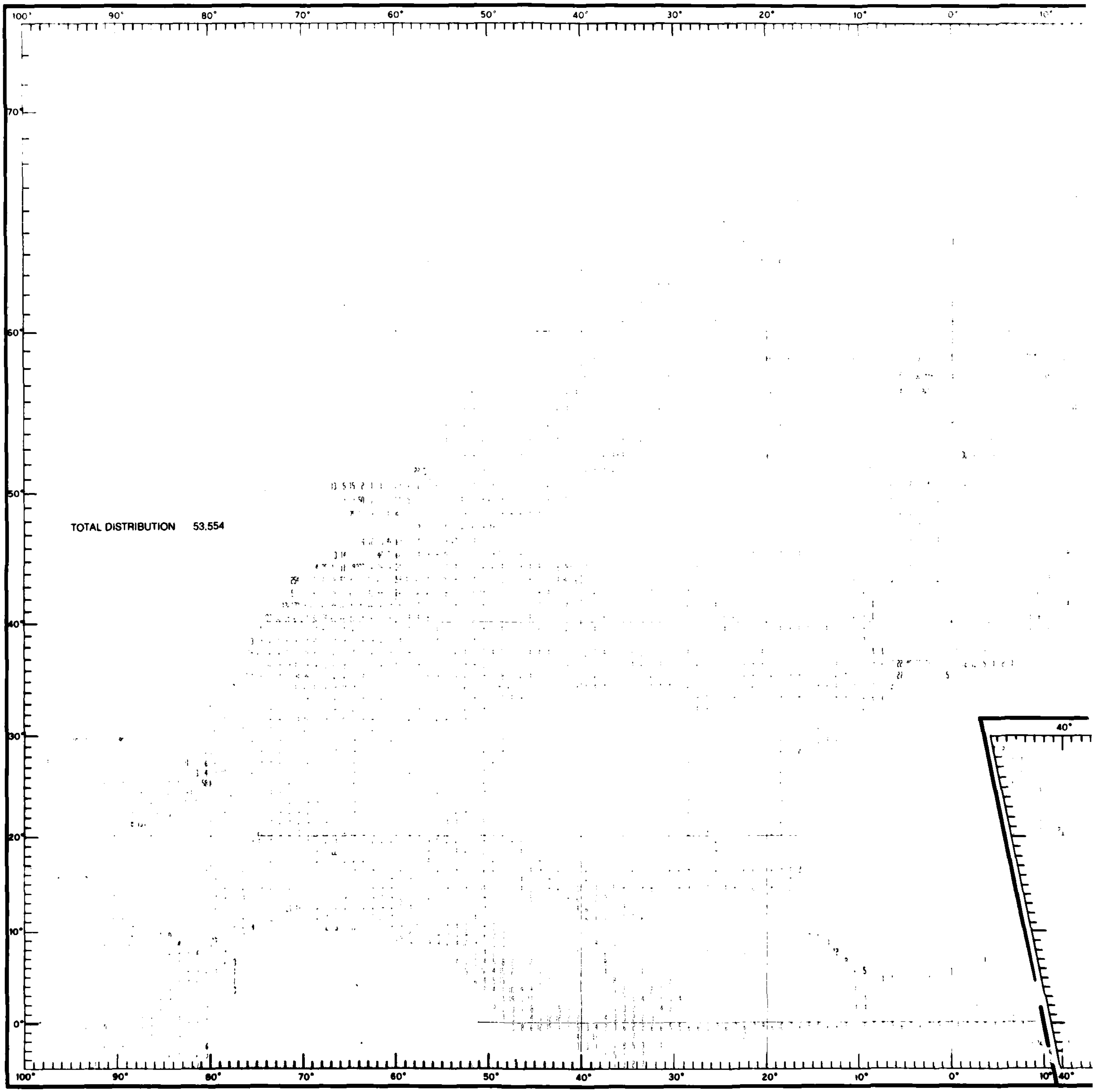
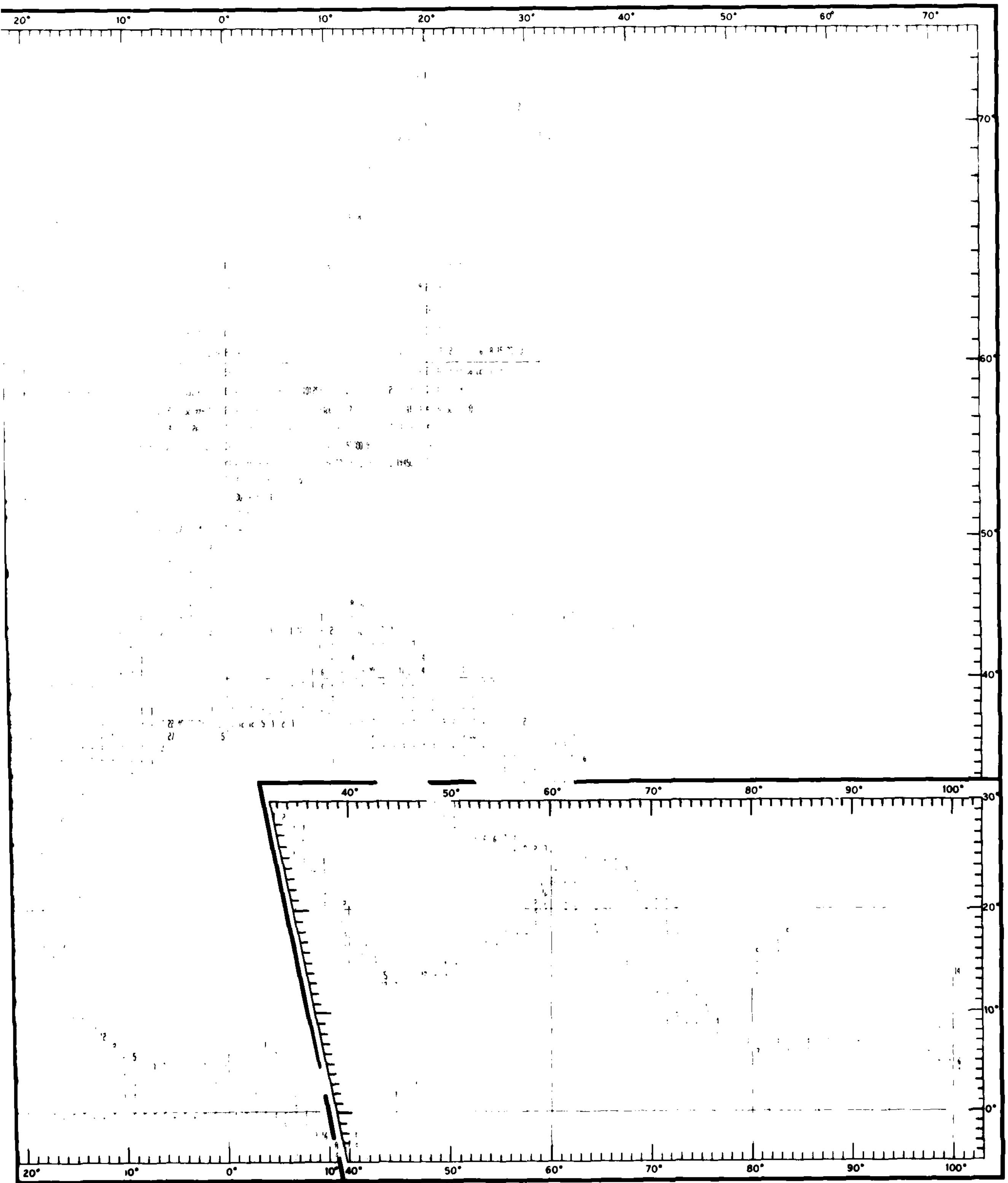


FIGURE 141. NOVEMBER DATA DISTRIBUTION OF TEMPERATURES AT THE SURFA



DISTRIBUTION OF TEMPERATURES AT THE SURFACE

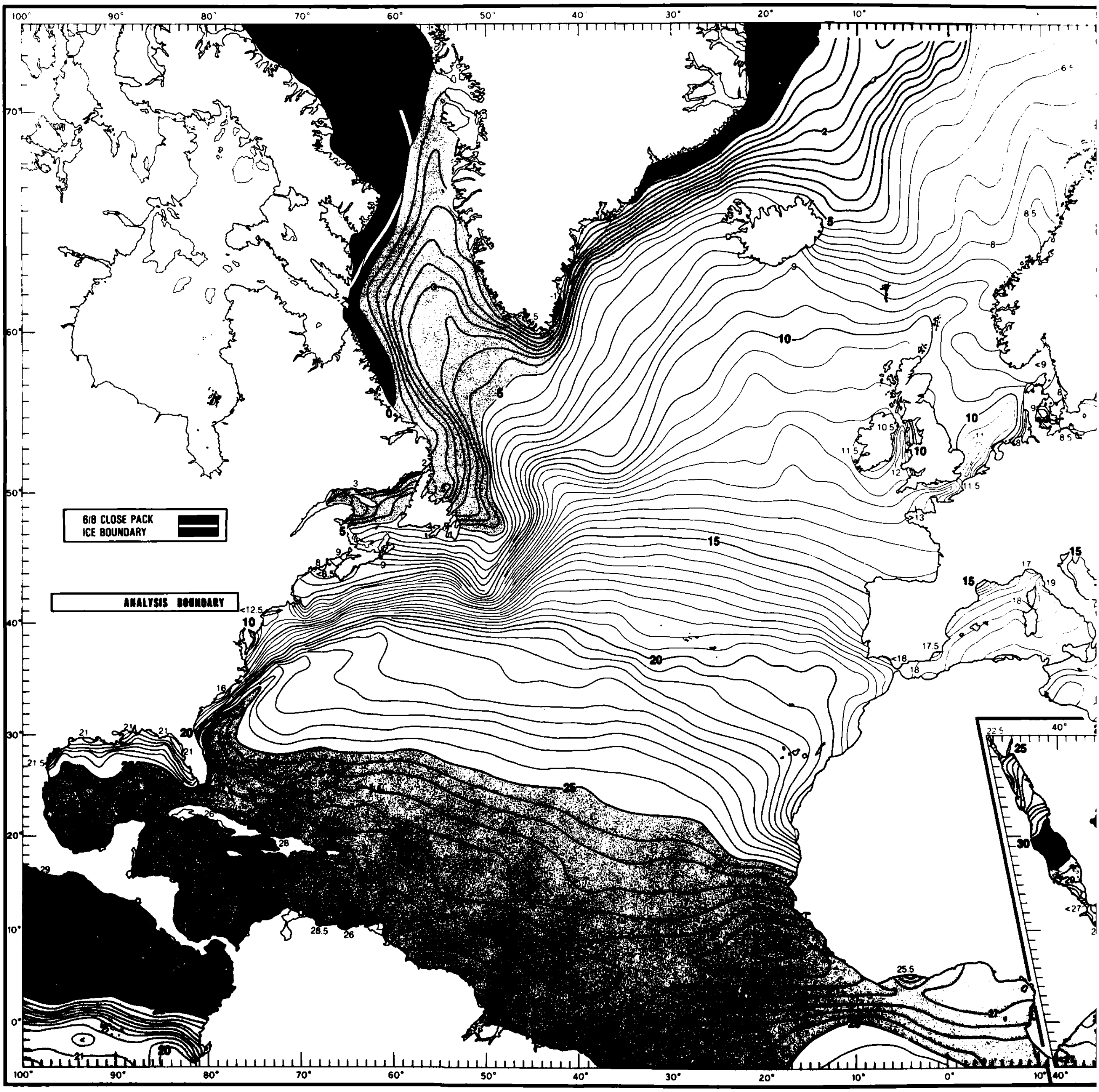
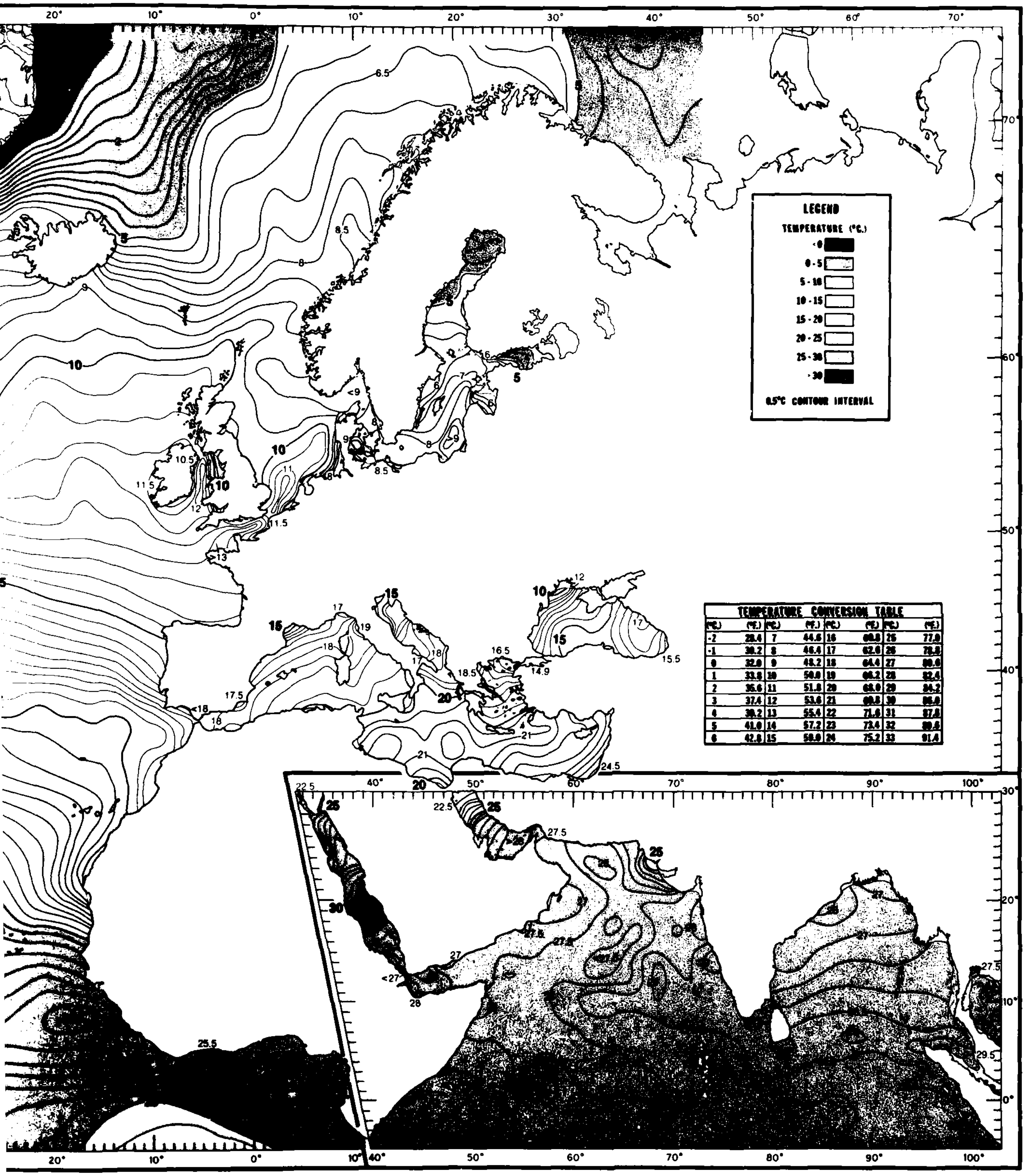


FIGURE 142. NOVEMBER MEAN TEMPERATURES AT THE SURFACE



TEMPERATURE CONVERSION TABLE							
(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

I MEAN TEMPERATURES AT THE SURFACE

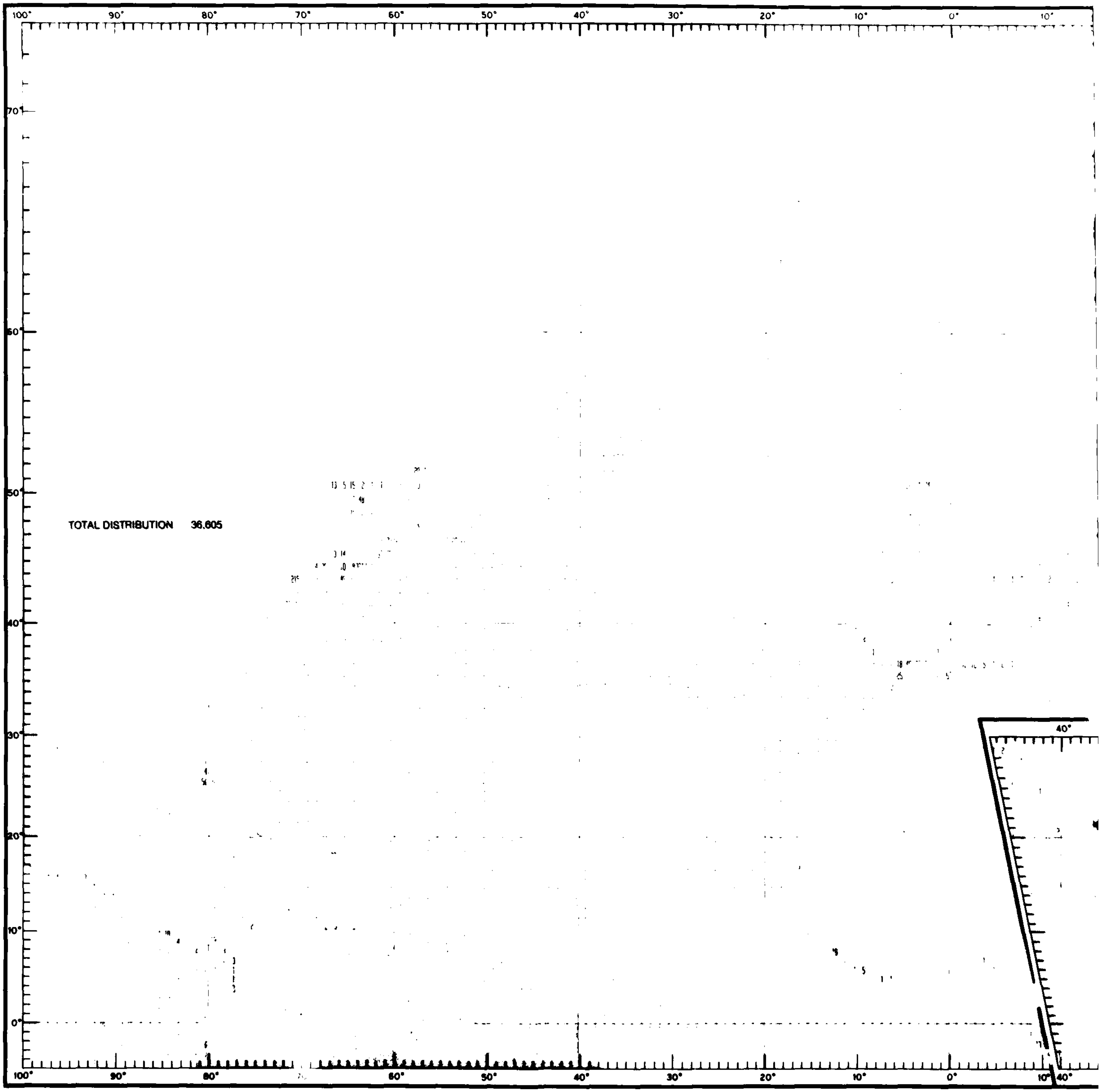
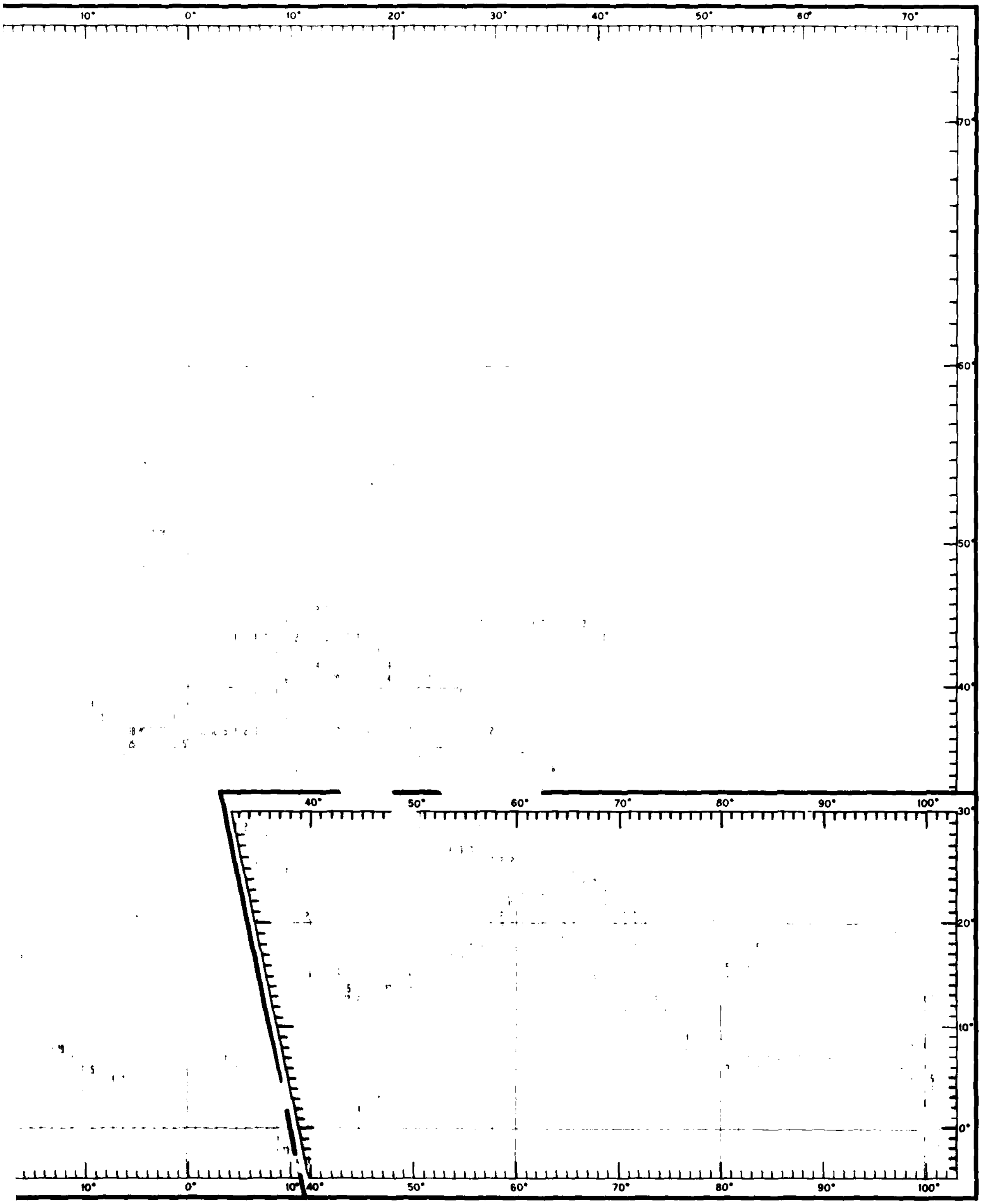


FIGURE 143. NOVEMBER DATA DISTRIBUTION OF TEMPERATURES AT 100 FT (30 M



BUTION OF TEMPERATURES AT 100 FT (30 M)

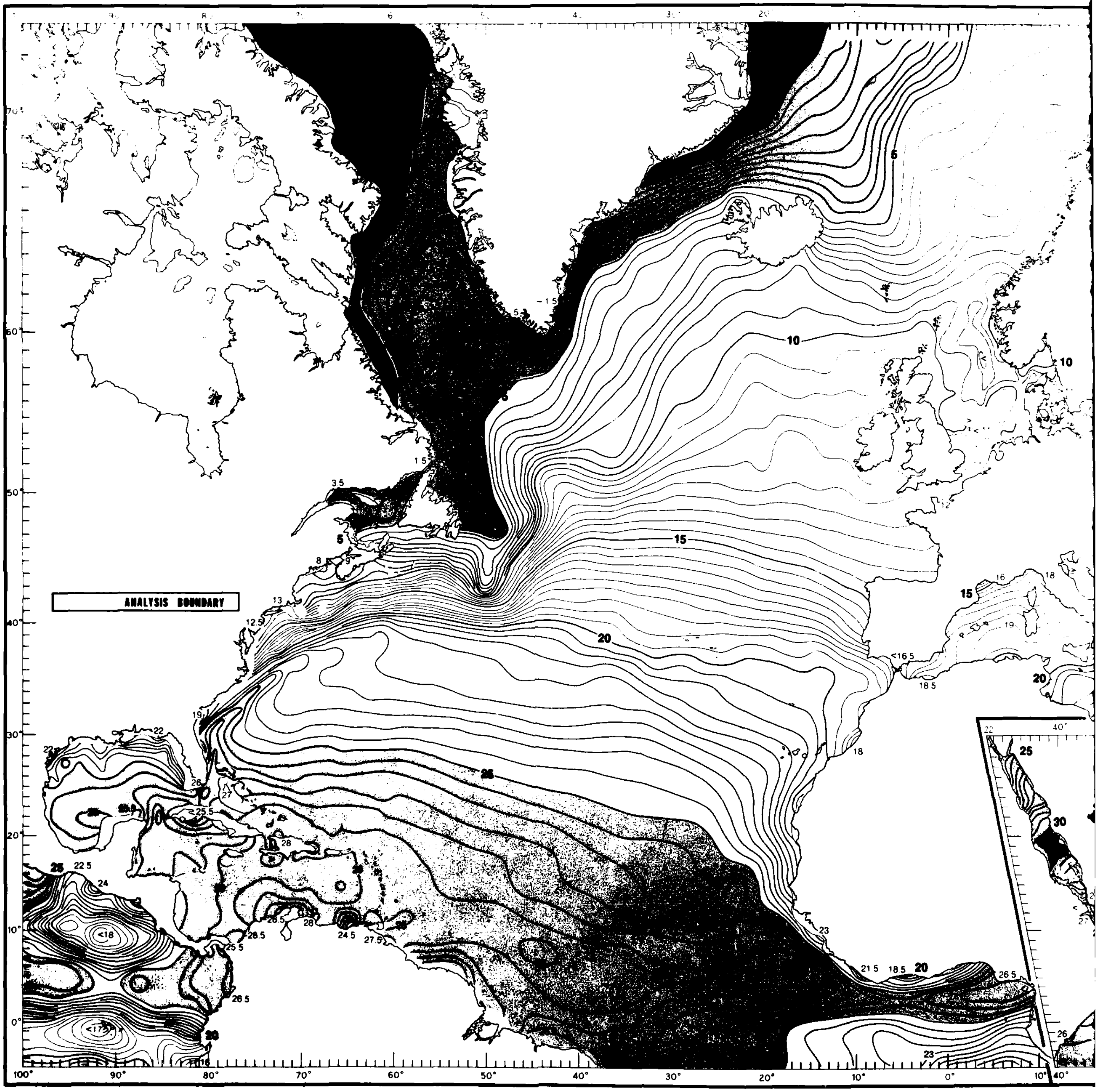
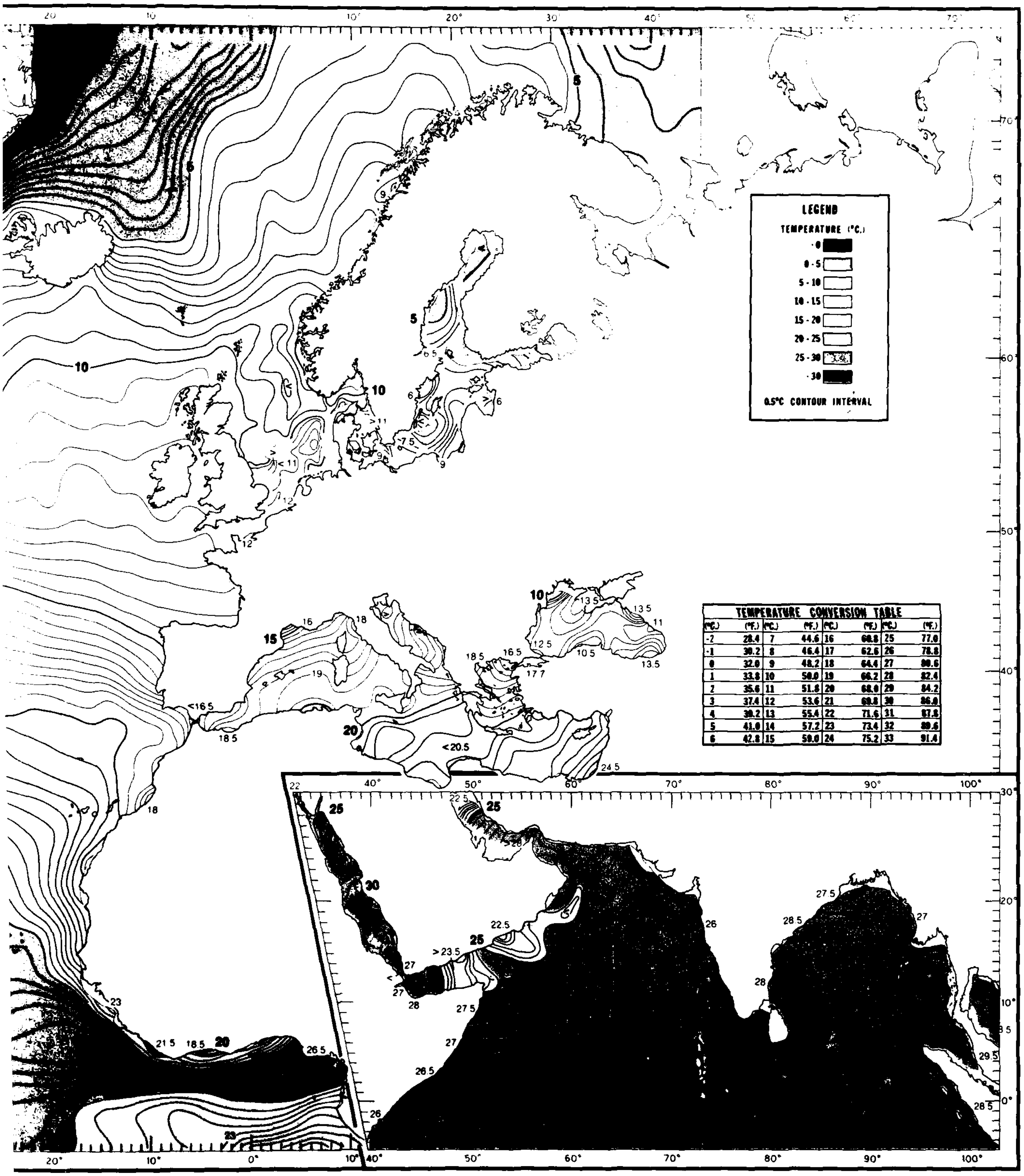


FIGURE 144. NOVEMBER MEAN TEMPERATURES AT 100 FT (30 M)



TEMPERATURE CONVERSION TABLE							
(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

ER MEAN TEMPERATURES AT 100 FT (30 M)

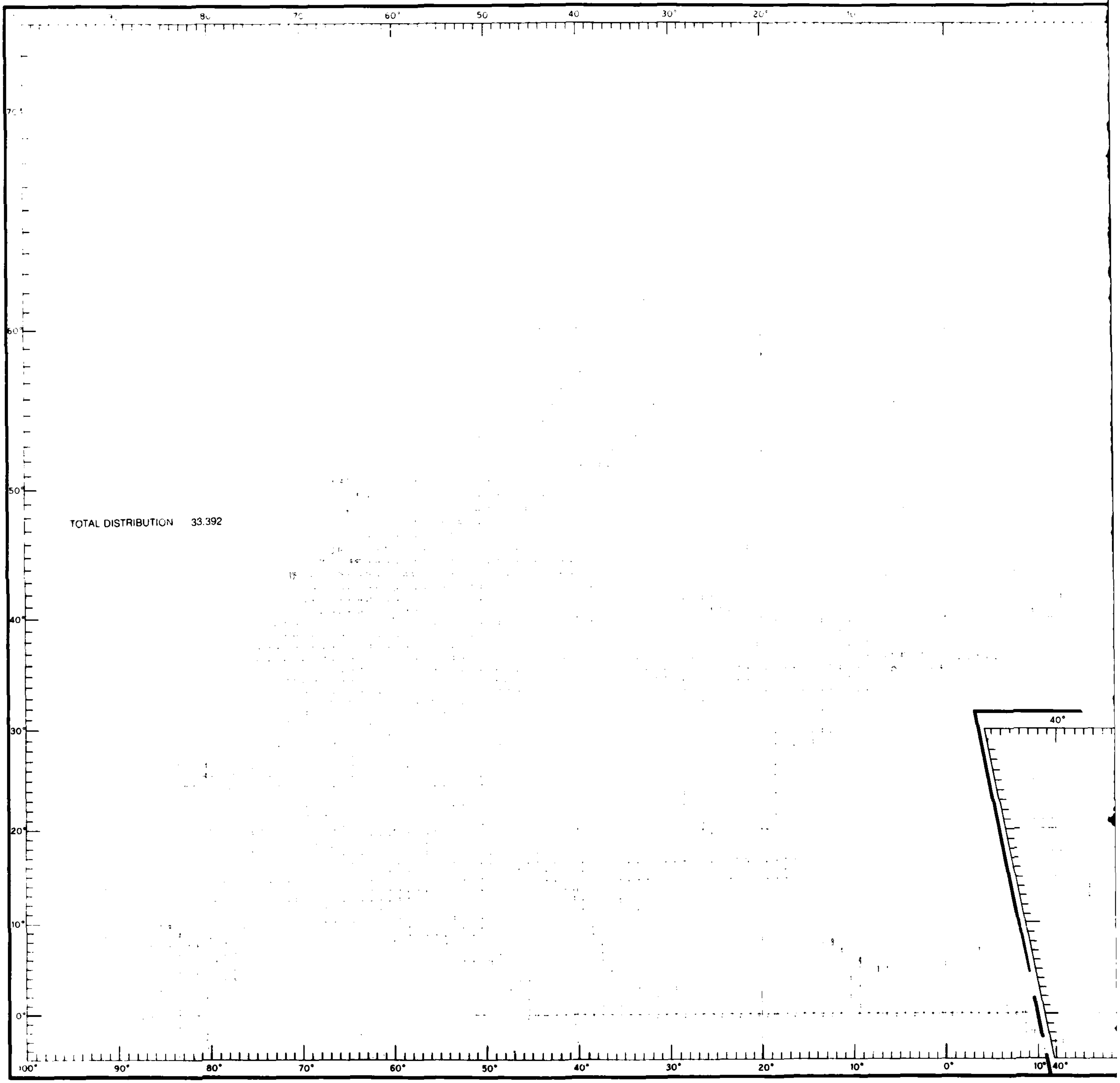
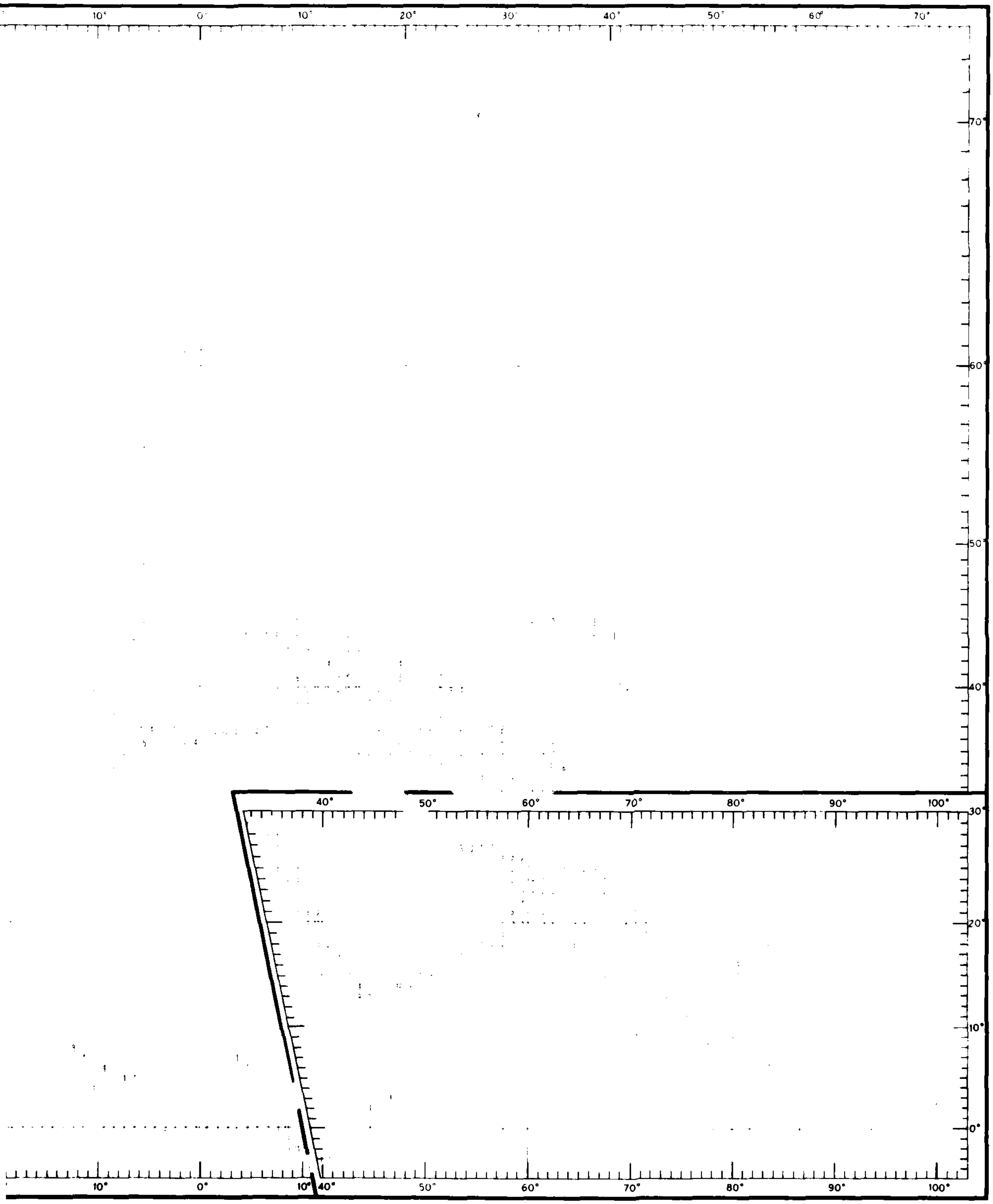


FIGURE 145. NOVEMBER DATA DISTRIBUTION OF TEMPERATURES AT 200 FT (60 M)



STRIBUTION OF TEMPERATURES AT 200 FT (60 M)

1 2

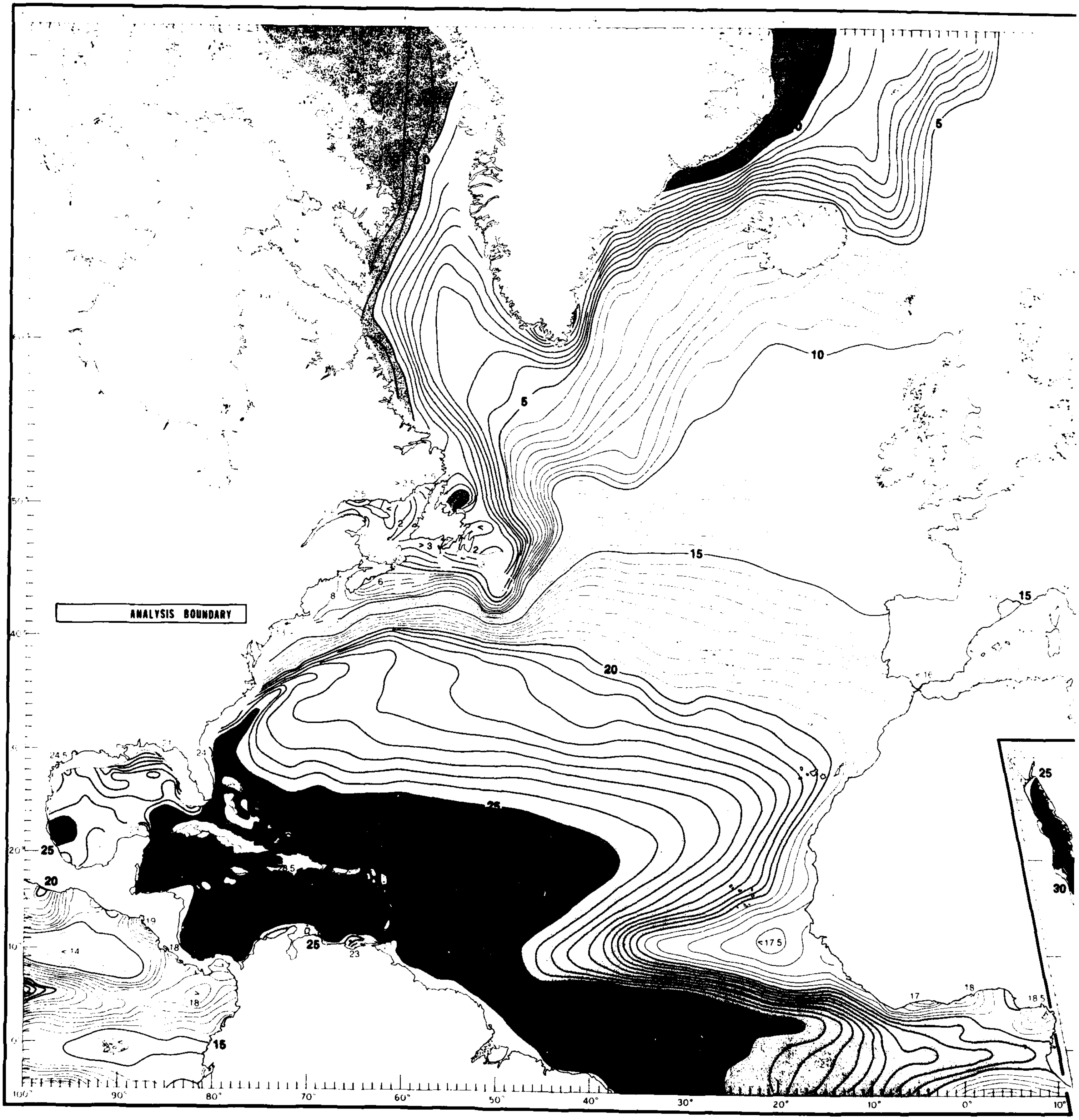
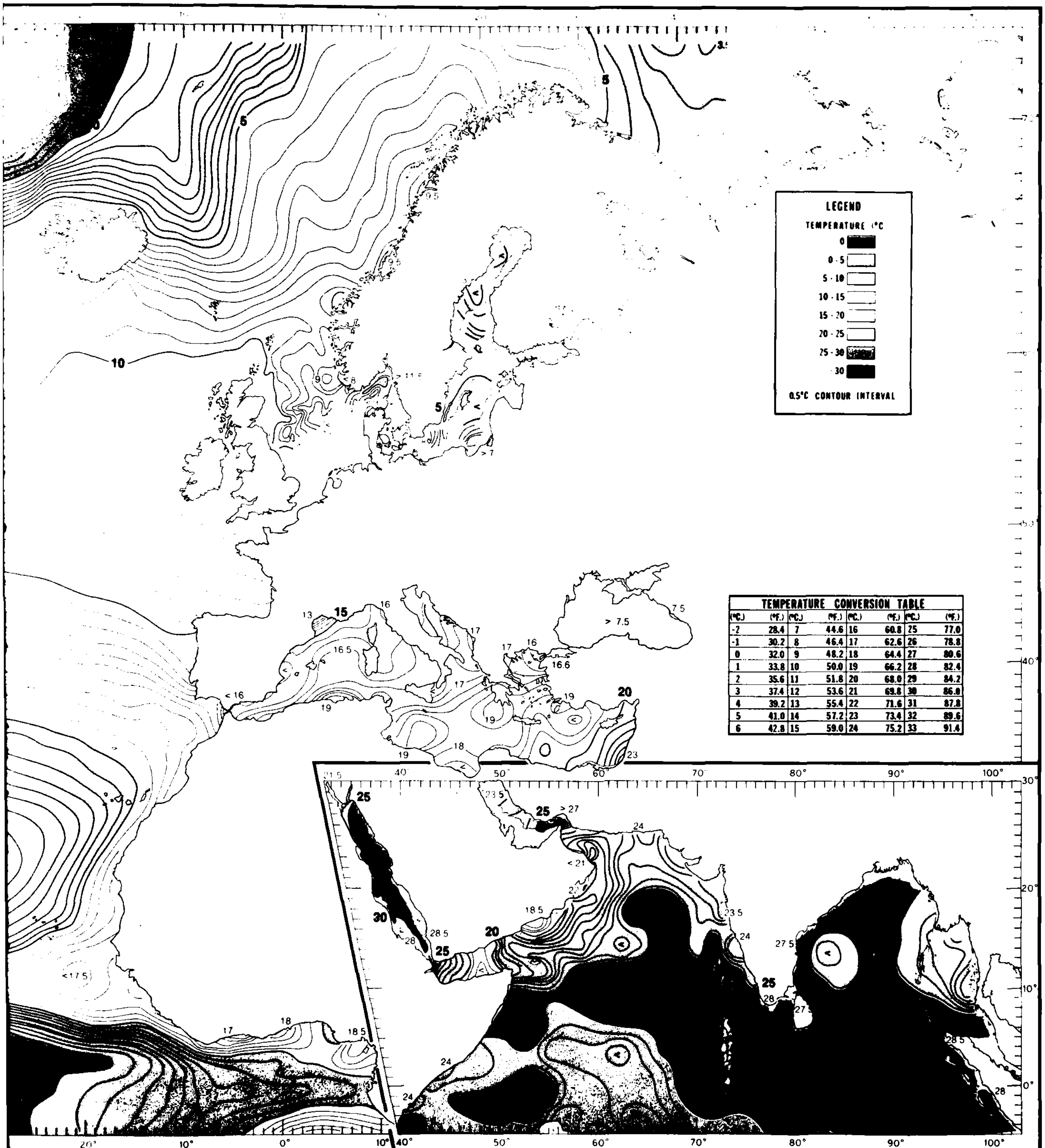


FIGURE 146. NOVEMBER MEAN TEMPERATURES AT 200 FT (60 M)



TEMPERATURE CONVERSION TABLE							
(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

EMBER MEAN TEMPERATURES AT 200 FT (60 M)

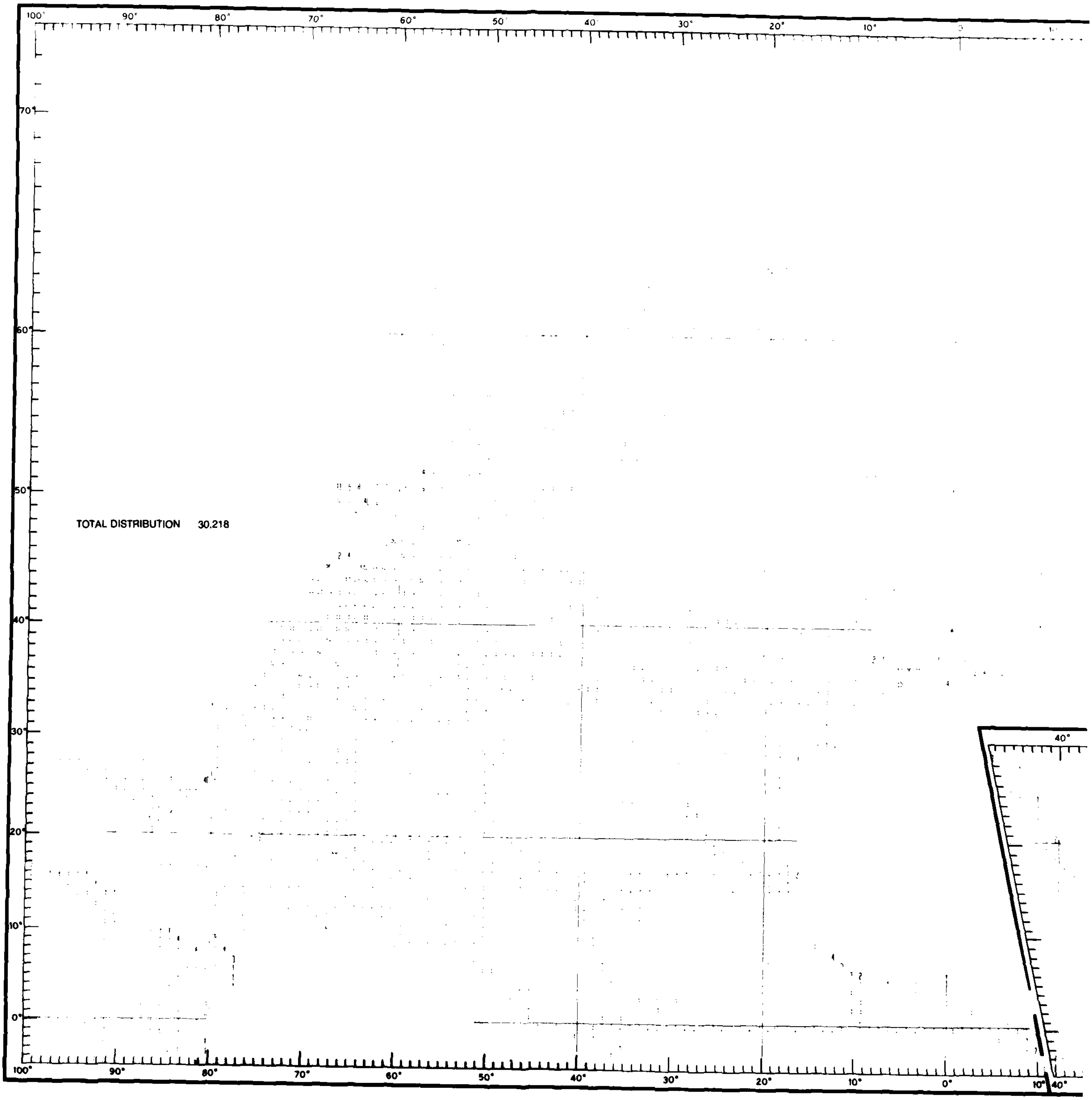
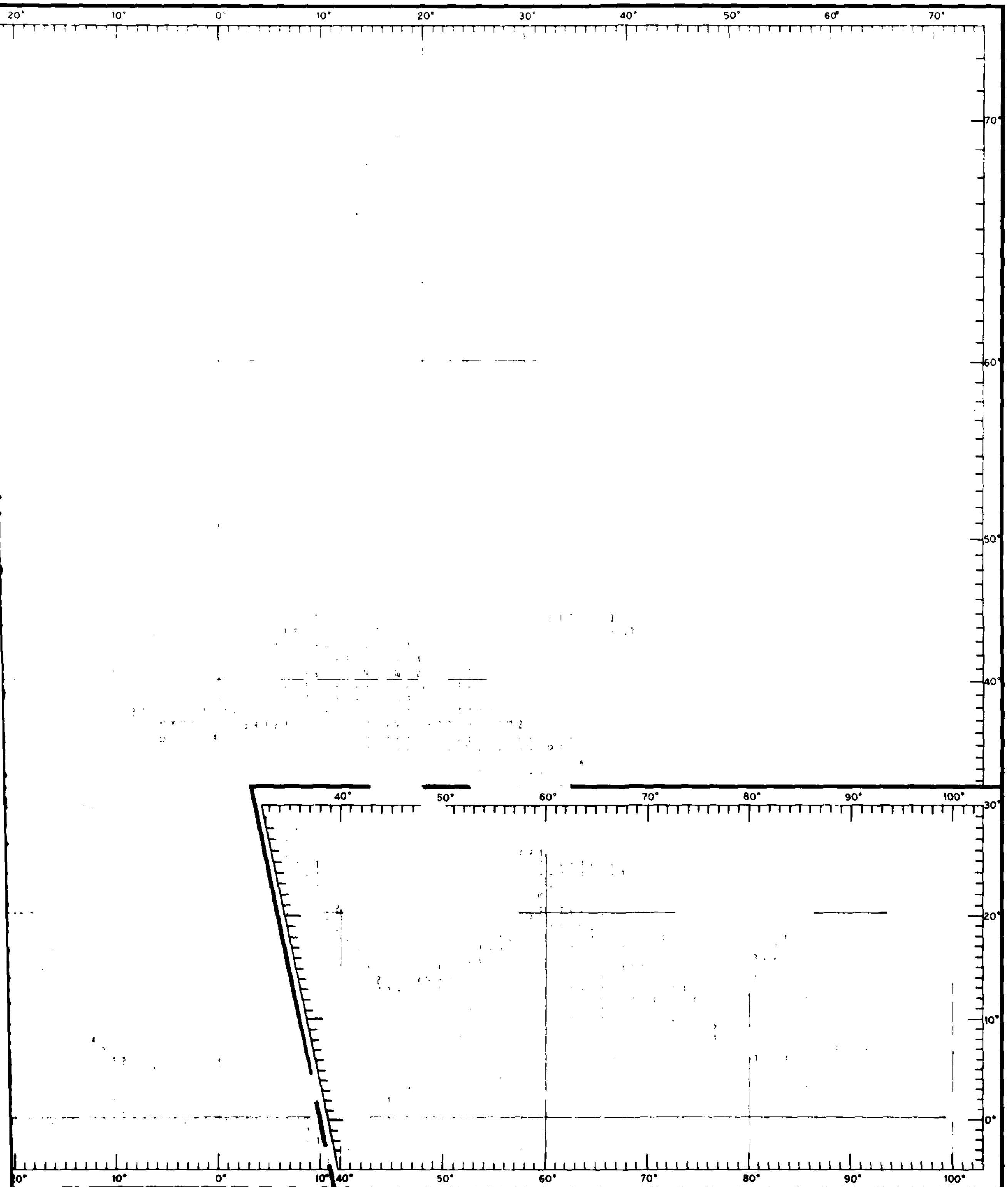


FIGURE 147. NOVEMBER DATA DISTRIBUTION OF TEMPERATURES AT 300 FT (90

1



ISTRIBUTION OF TEMPERATURES AT 300 FT (90 M)

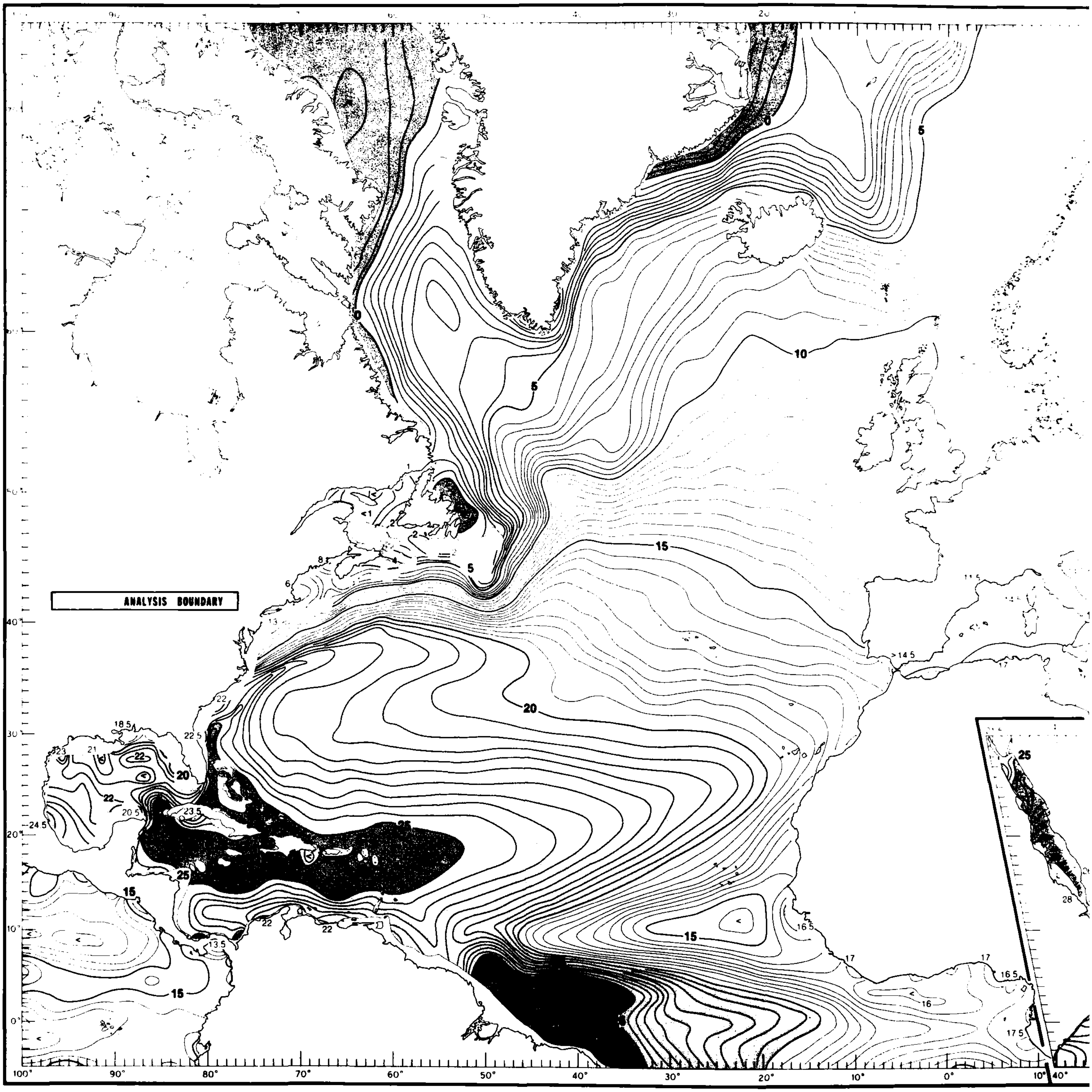
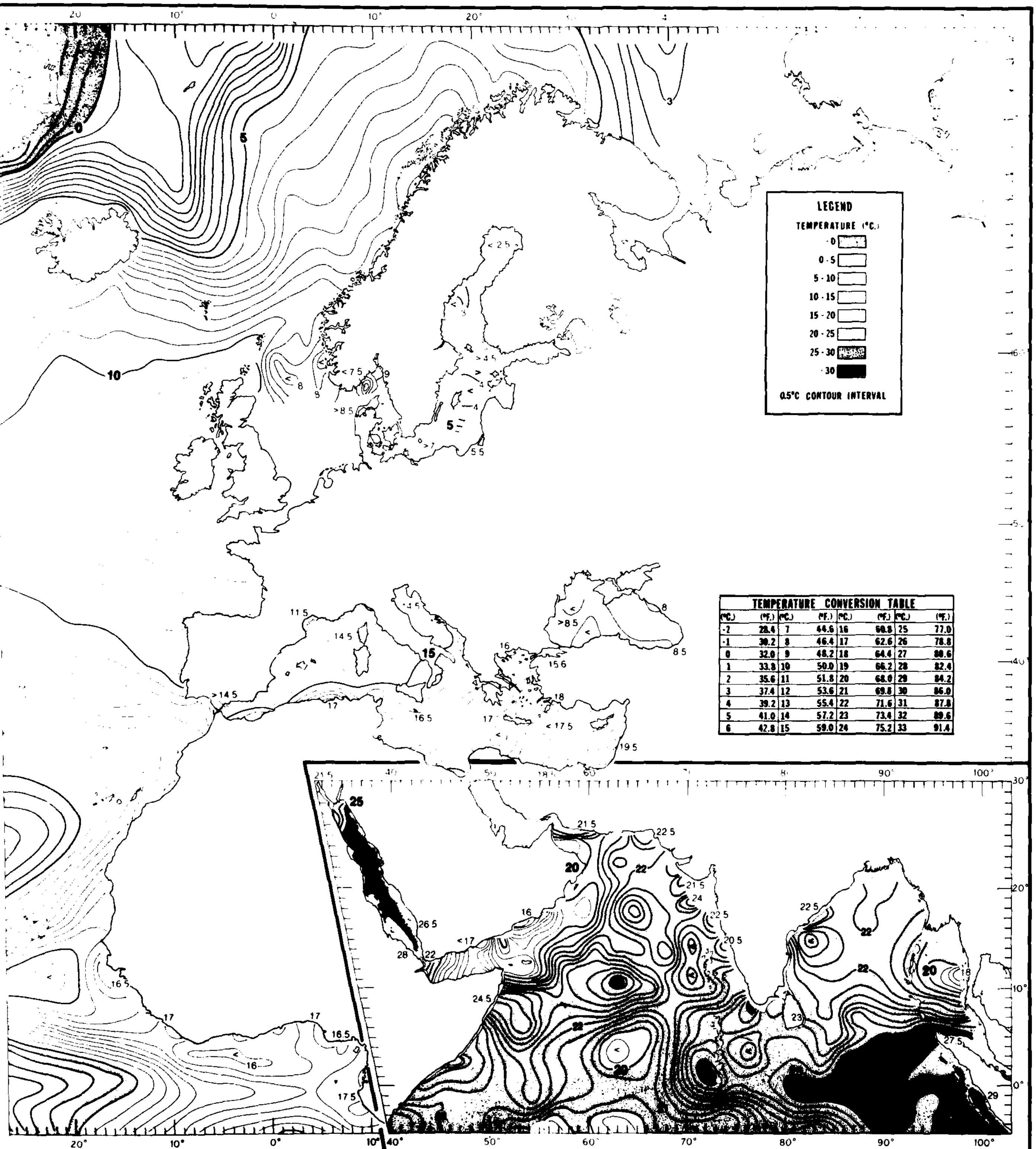


FIGURE 148. NOVEMBER MEAN TEMPERATURES AT 300 FT (90 M)



TEMPERATURE CONVERSION TABLE							
(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

EMBER MEAN TEMPERATURES AT 300 FT (90 M)

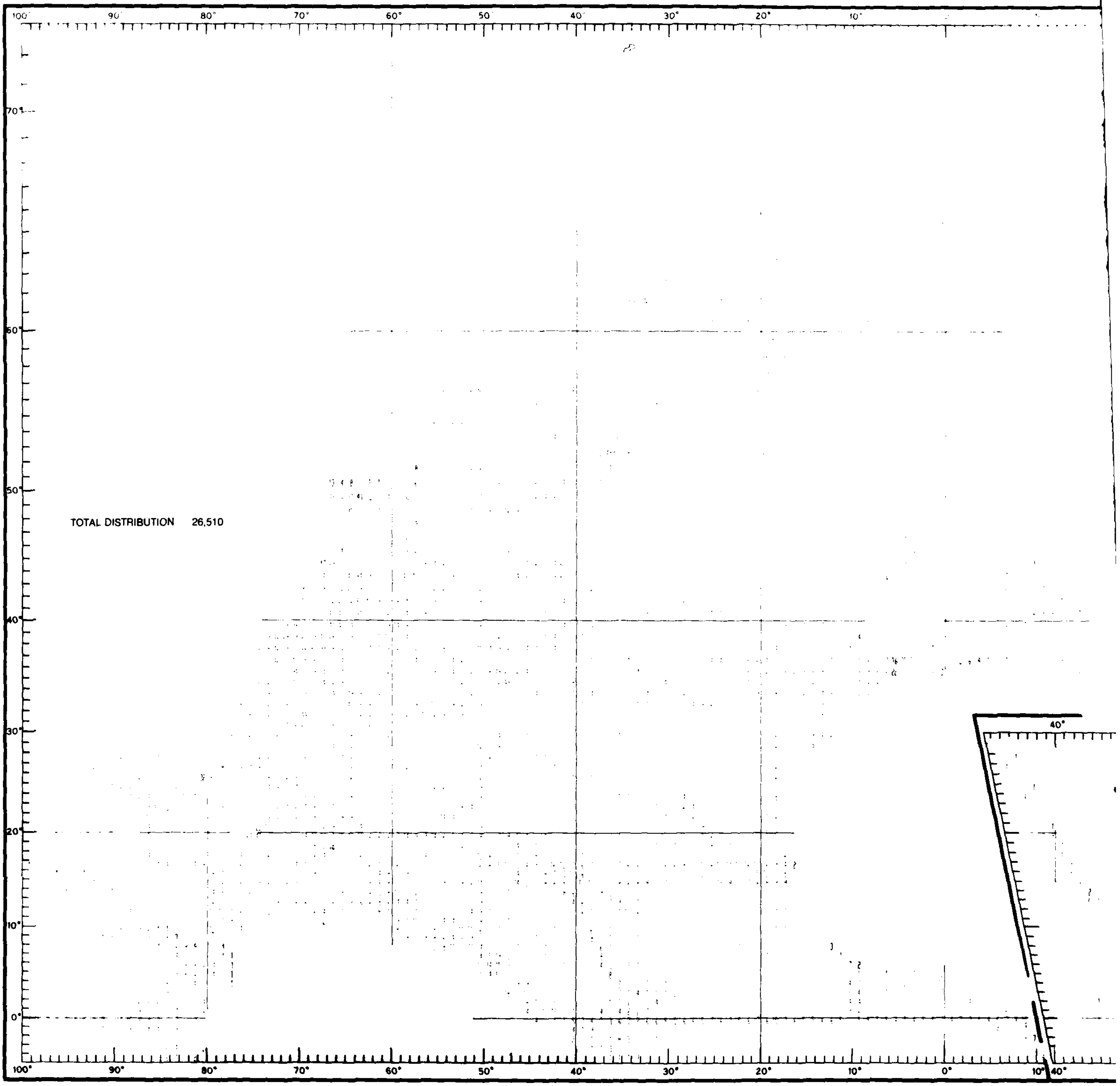
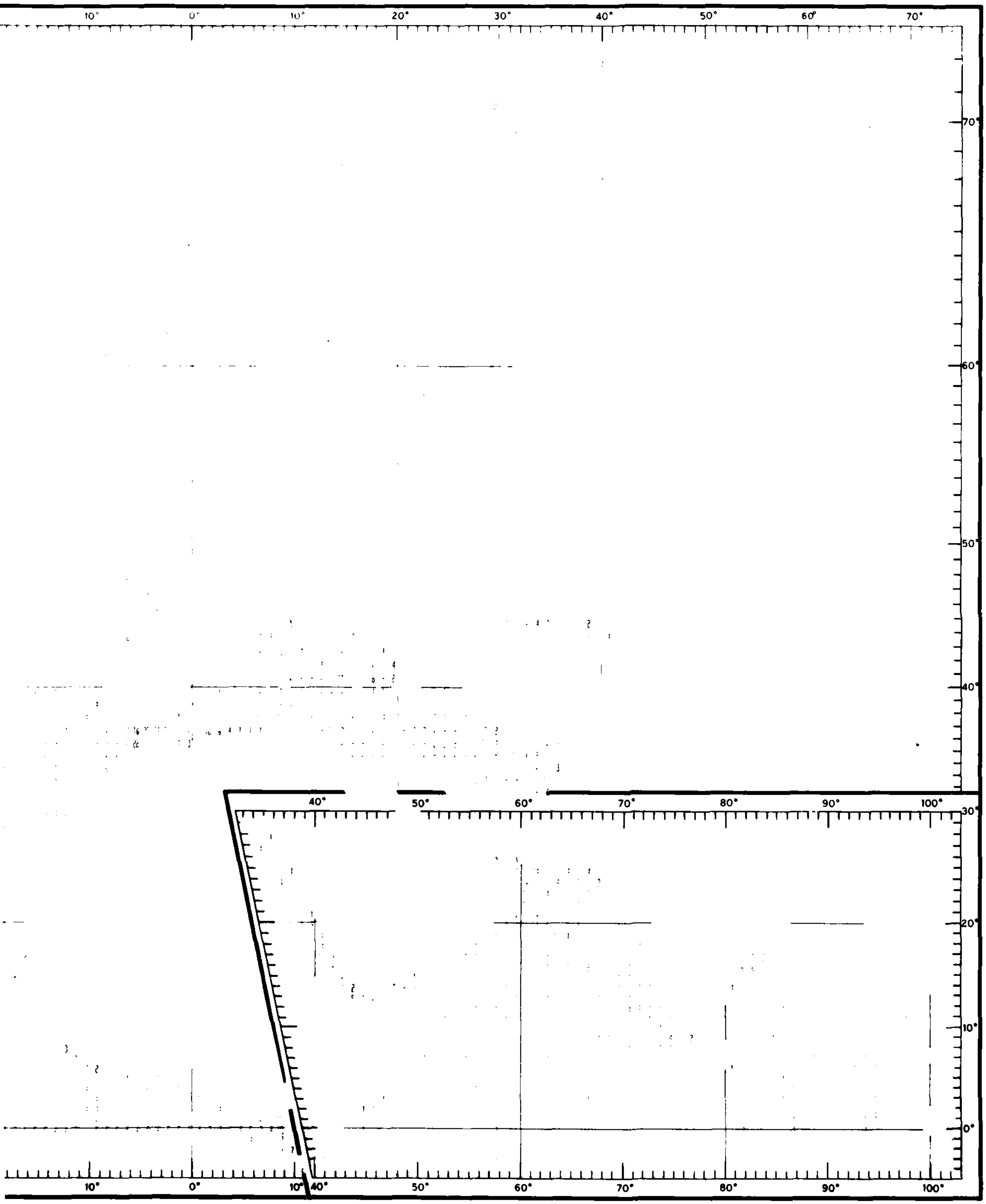


FIGURE 149. NOVEMBER DATA DISTRIBUTION OF TEMPERATURES AT 400 FT (120 M)



RIBUTION OF TEMPERATURES AT 400 FT (120 M)

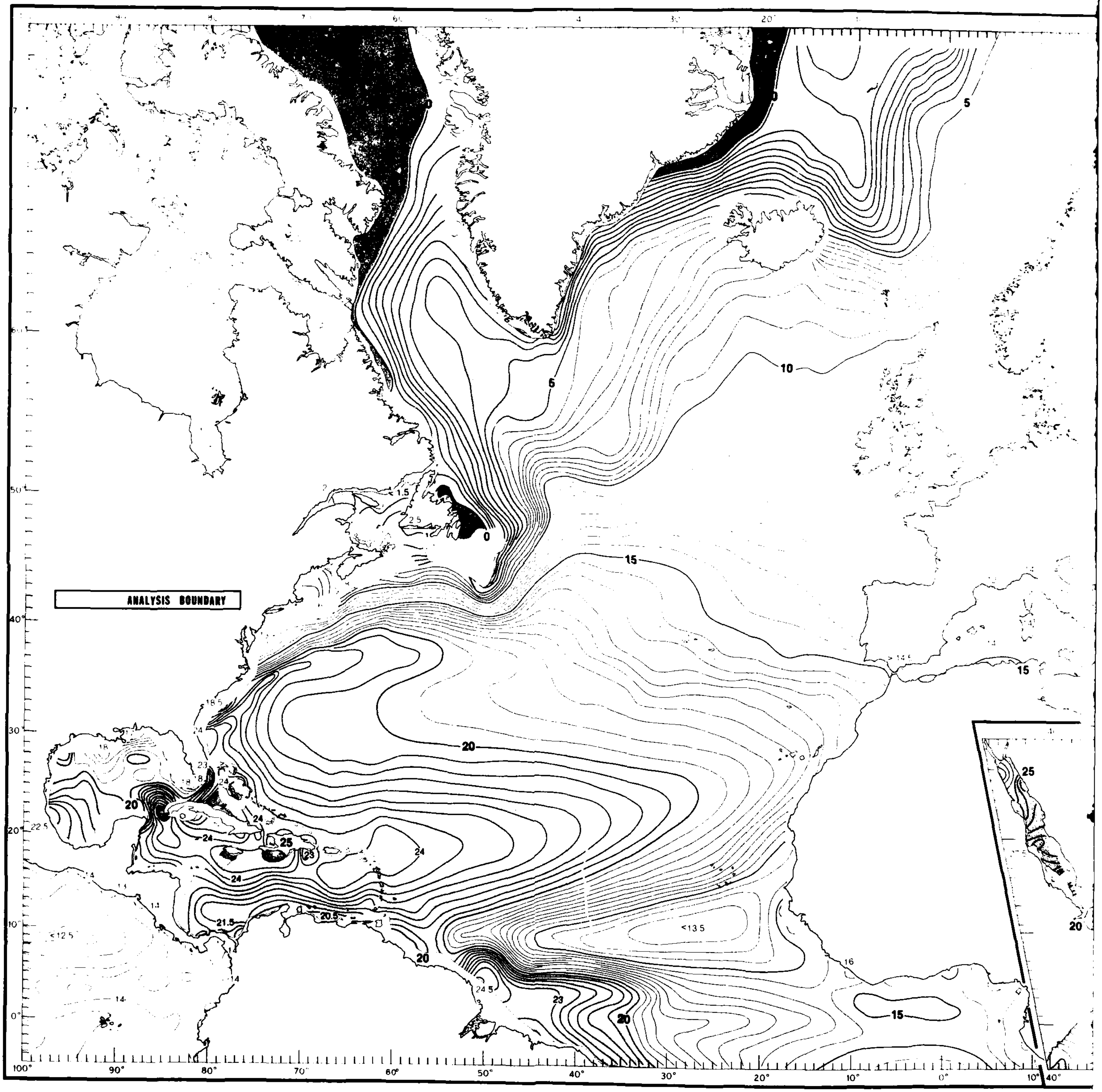
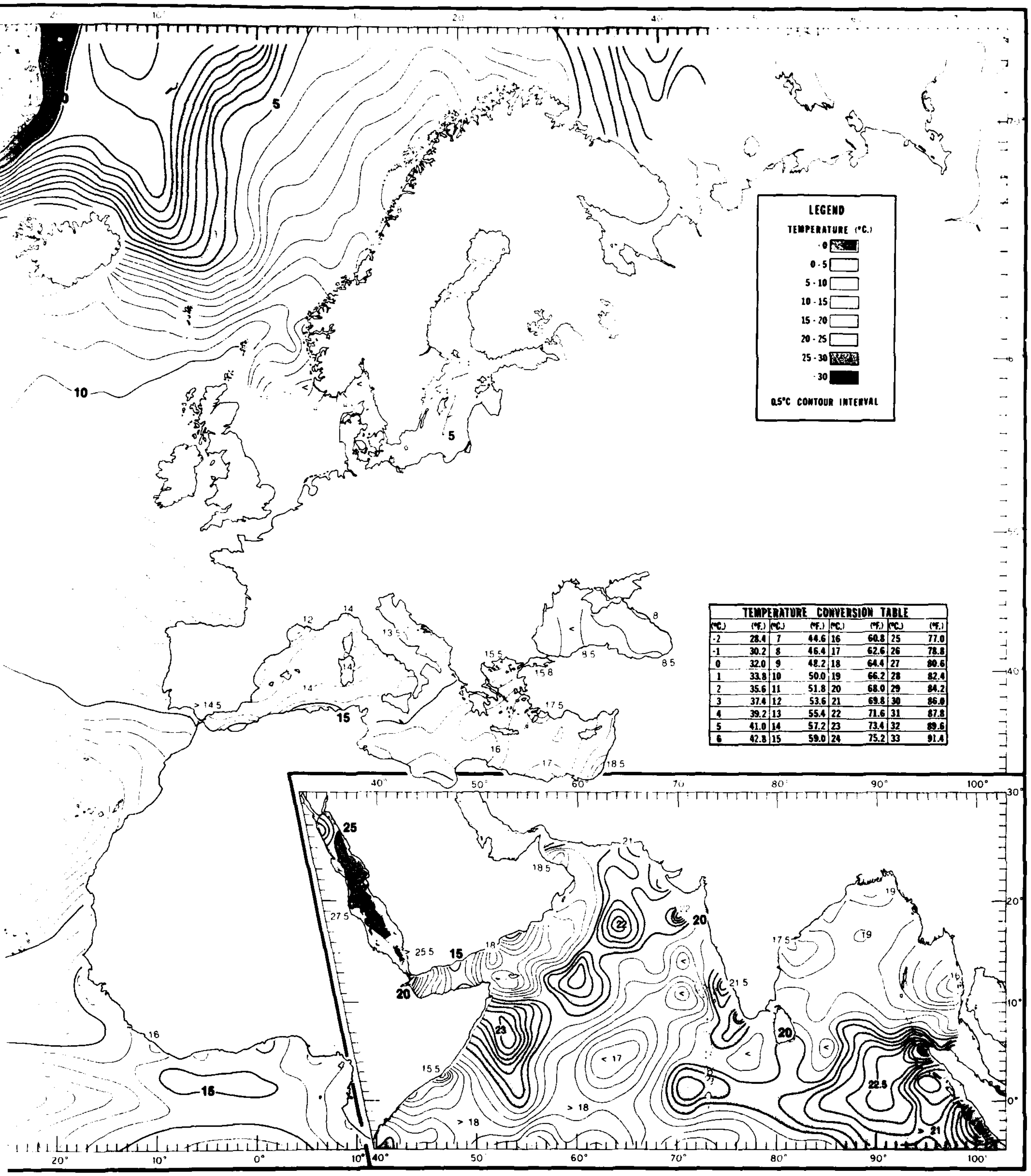


FIGURE 150. NOVEMBER MEAN TEMPERATURES AT 400 FT (120 M)



TEMPERATURE CONVERSION TABLE							
(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

MBER MEAN TEMPERATURES AT 400 FT (120 M)

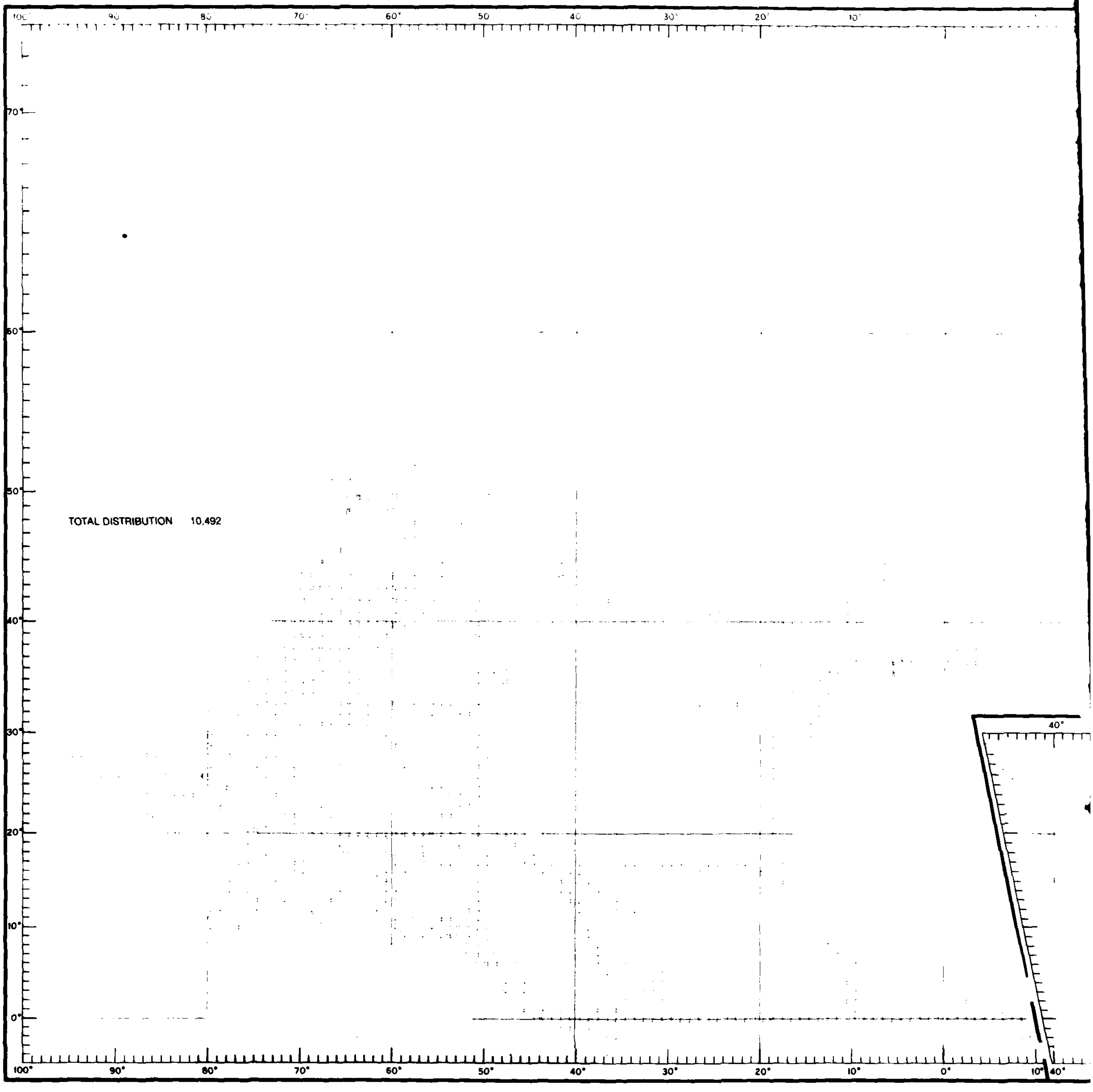
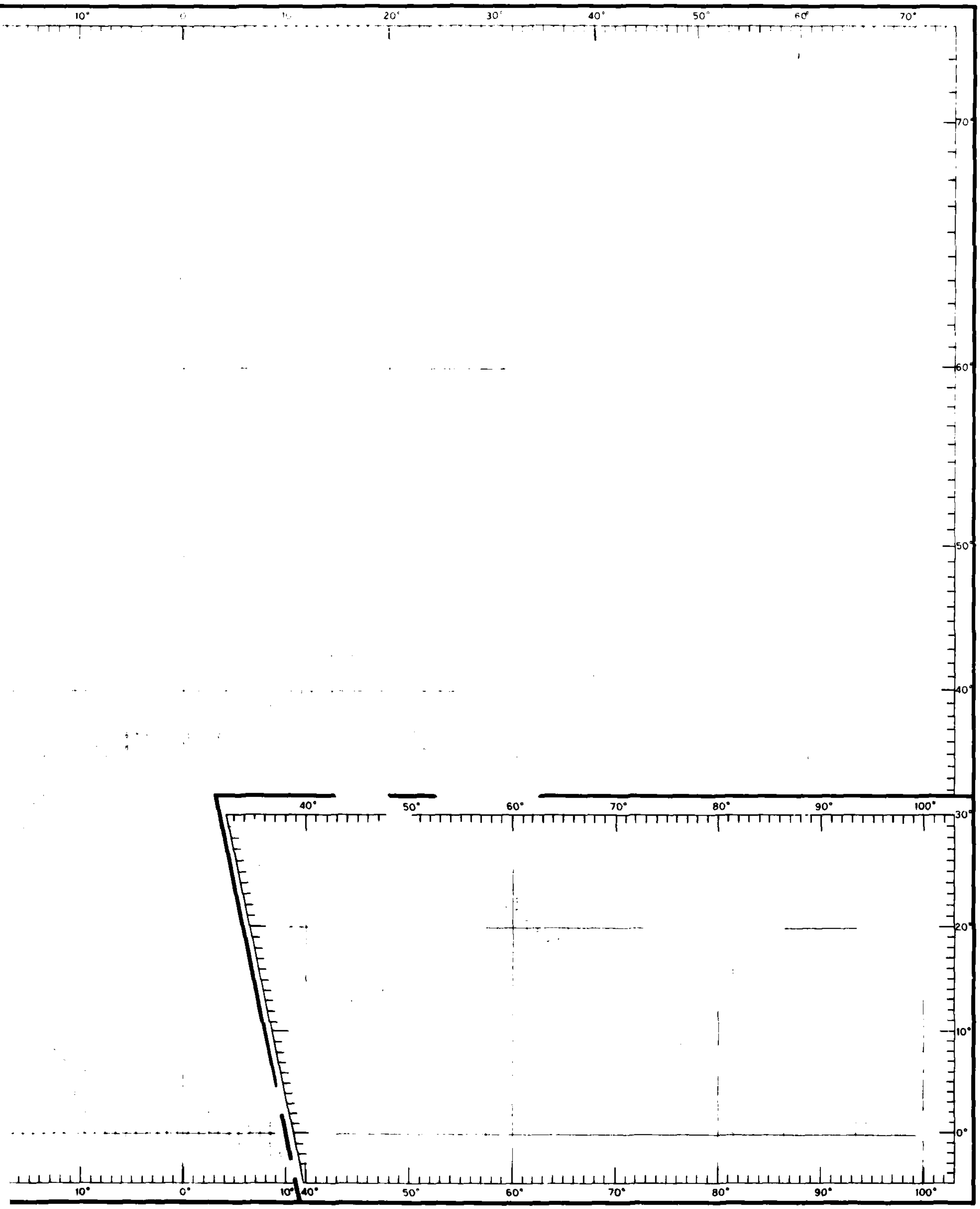


FIGURE 151. NOVEMBER DATA DISTRIBUTION OF TEMPERATURES AT 492 FT (150 M



BUTION OF TEMPERATURES AT 492 FT (150 M)

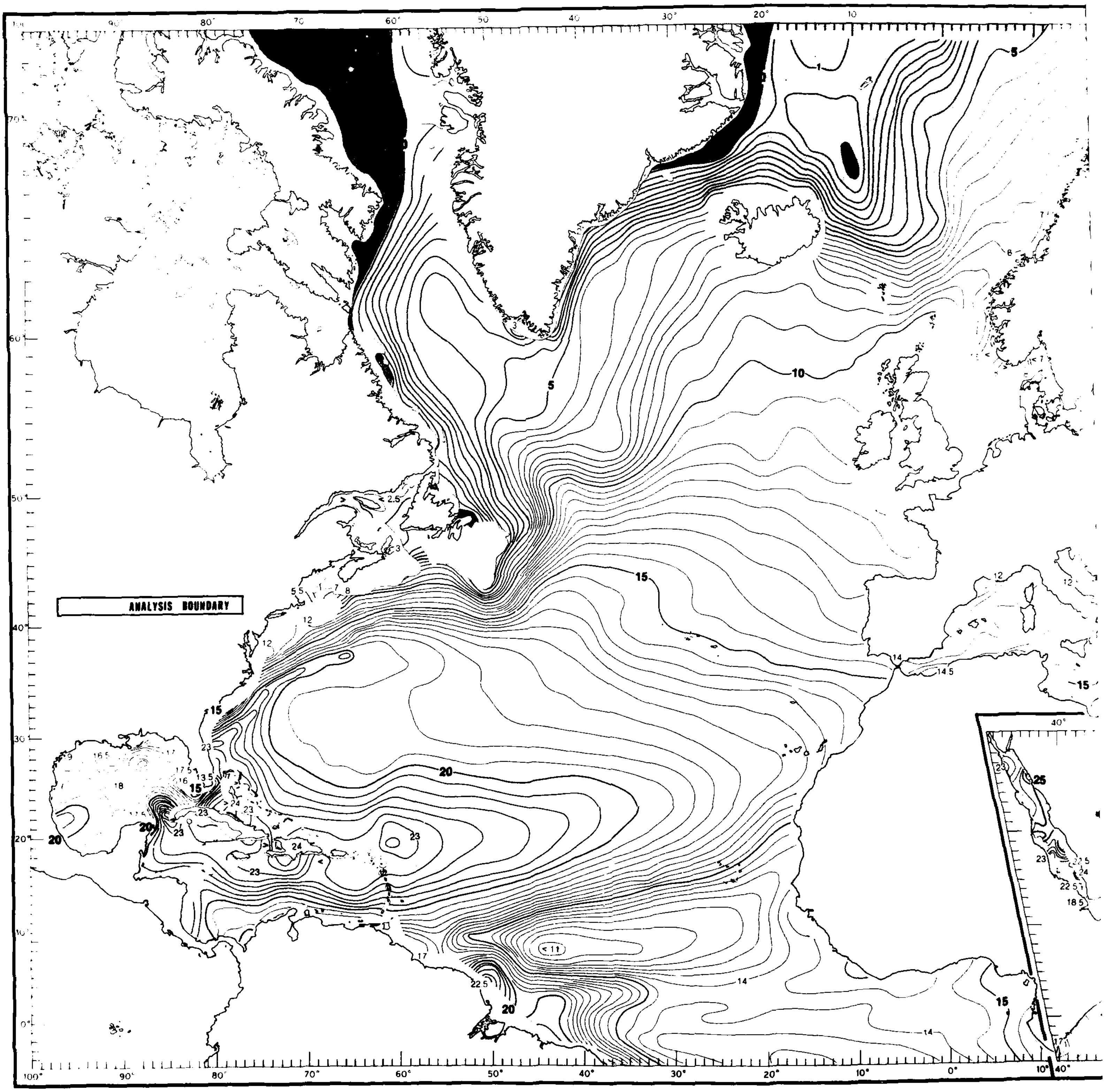
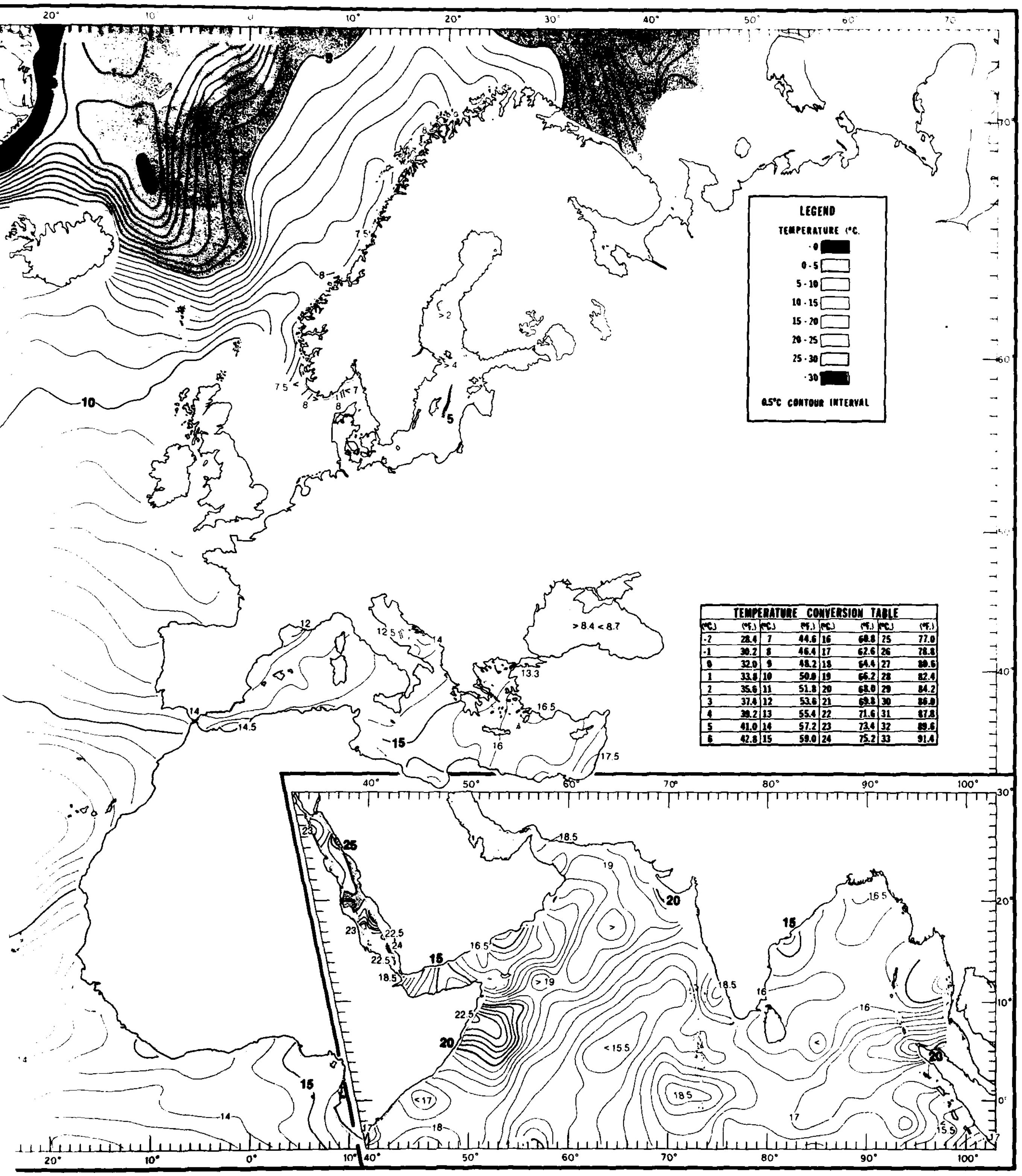


FIGURE 152. NOVEMBER MEAN TEMPERATURES AT 492 FT (150 M)



TEMPERATURE CONVERSION TABLE							
(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

MEAN TEMPERATURES AT 492 FT (150 M)

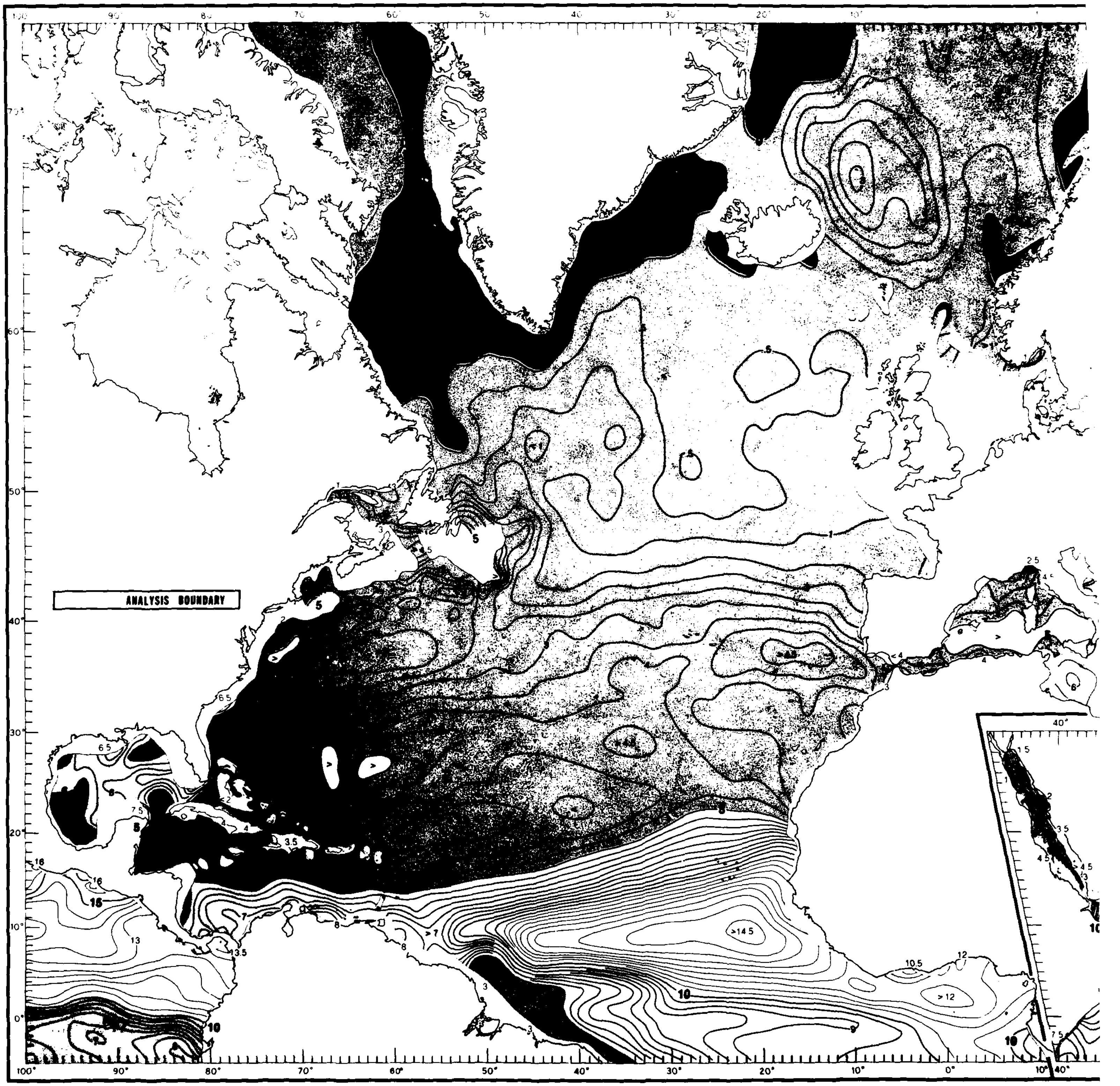
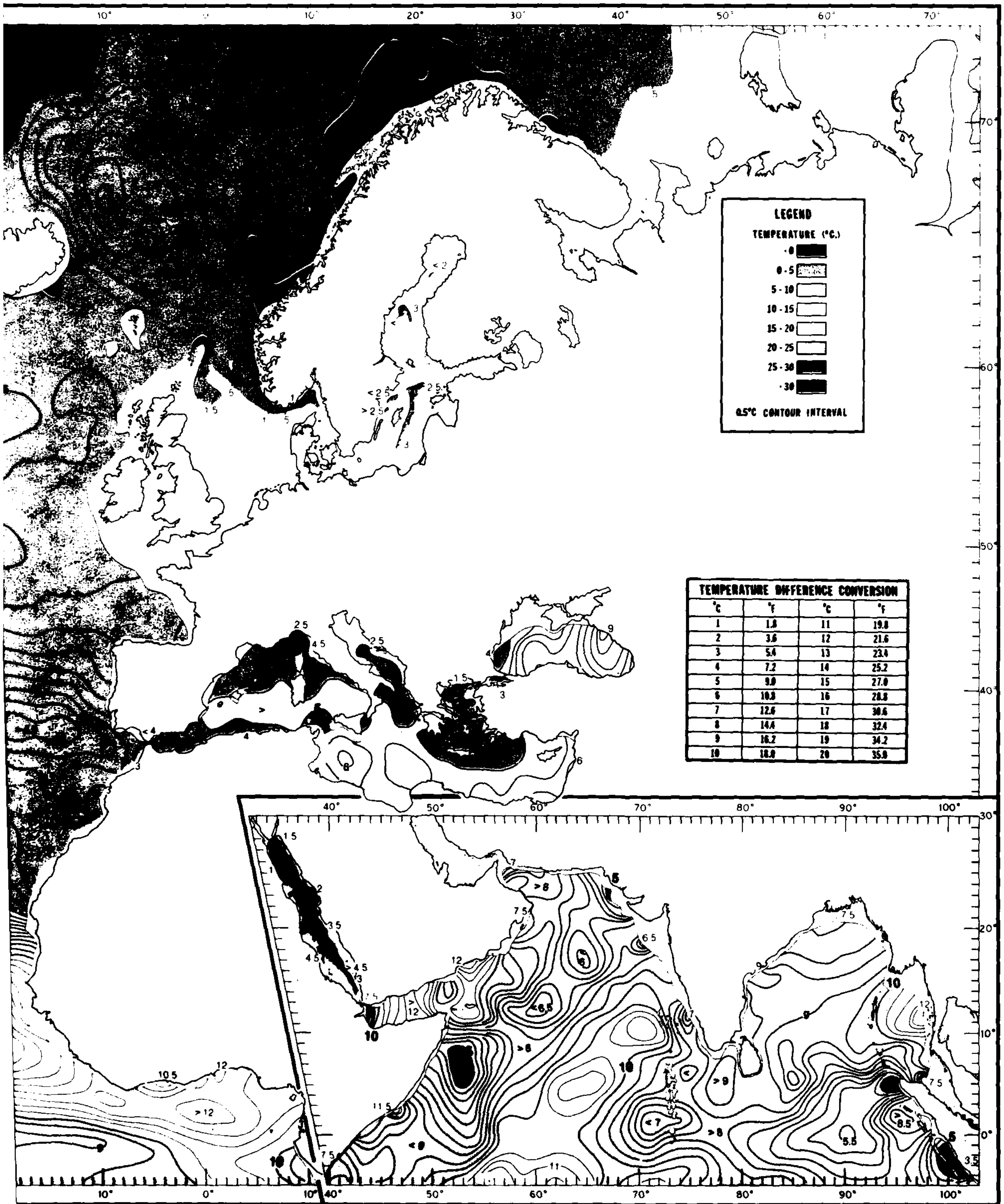


FIGURE 153. NOVEMBER TEMPERATURE DIFFERENCE BETWEEN THE SURFACE AND 400 FT (T



TEMPERATURE DIFFERENCE CONVERSION

°C	°F	°C	°F
1	1.8	11	19.8
2	3.6	12	21.6
3	5.4	13	23.4
4	7.2	14	25.2
5	9.0	15	27.0
6	10.8	16	28.8
7	12.6	17	30.6
8	14.4	18	32.4
9	16.2	19	34.2
10	18.0	20	35.8

RENCE BETWEEN THE SURFACE AND 400 FT (T_0-T_{400})

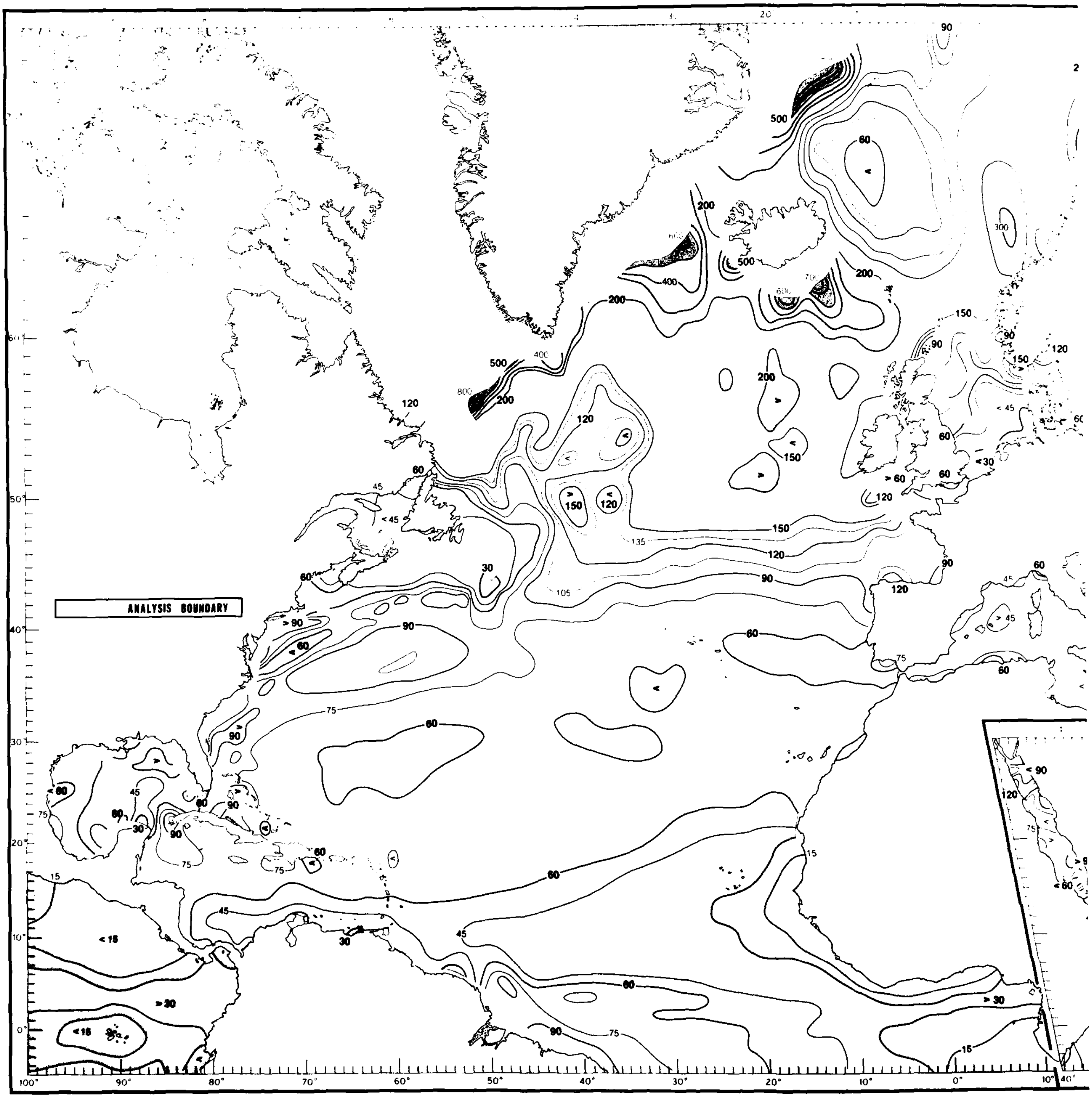
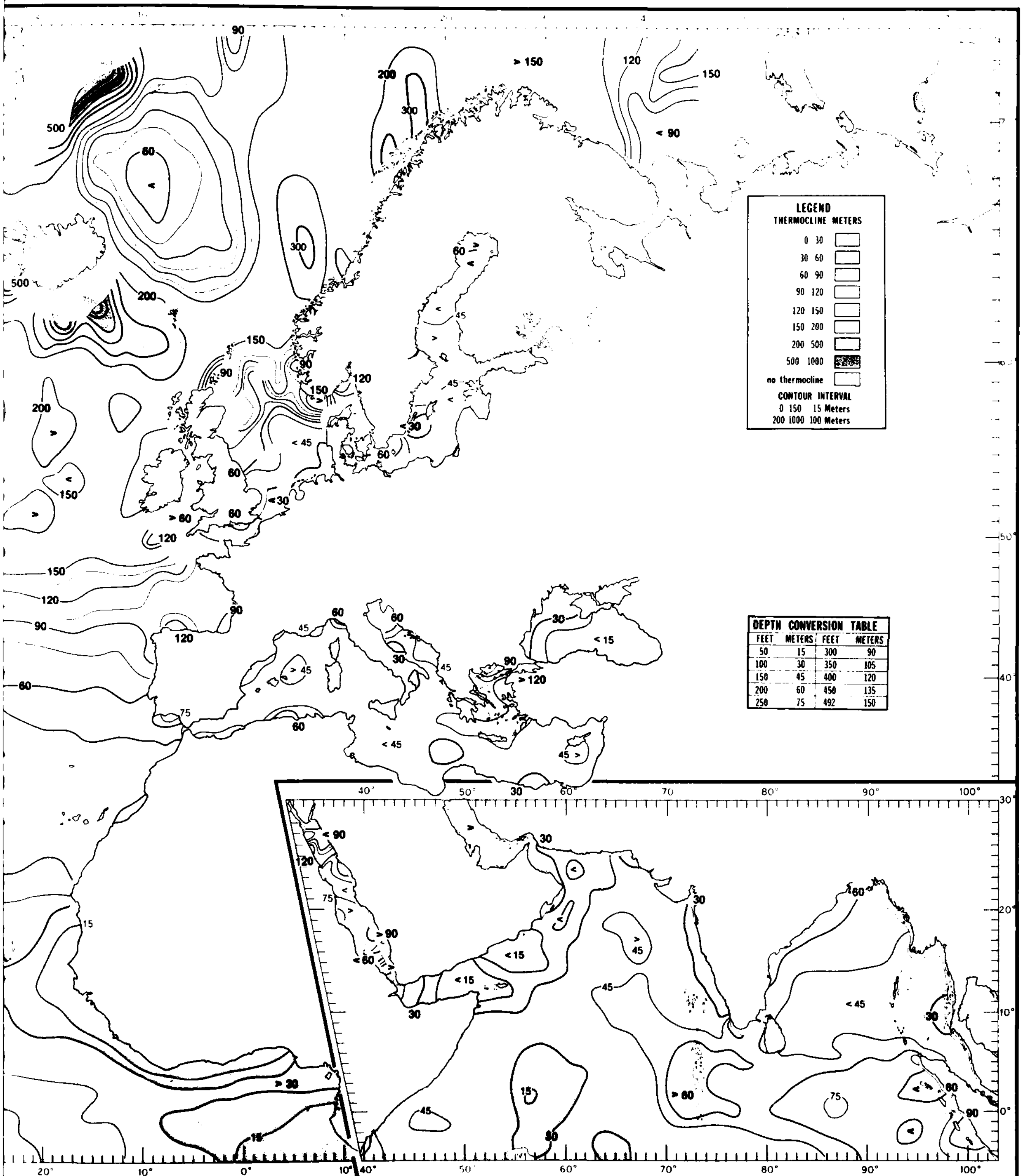


FIGURE 154. NOVEMBER MEAN DEPTHS TO THE TOP OF THE THERMOCLINE



DEPTH CONVERSION TABLE

FEET	METERS	FEET	METERS
50	15	300	90
100	30	350	105
150	45	400	120
200	60	450	135
250	75	492	150

MEAN DEPTHS TO THE TOP OF THE THERMOCLINE

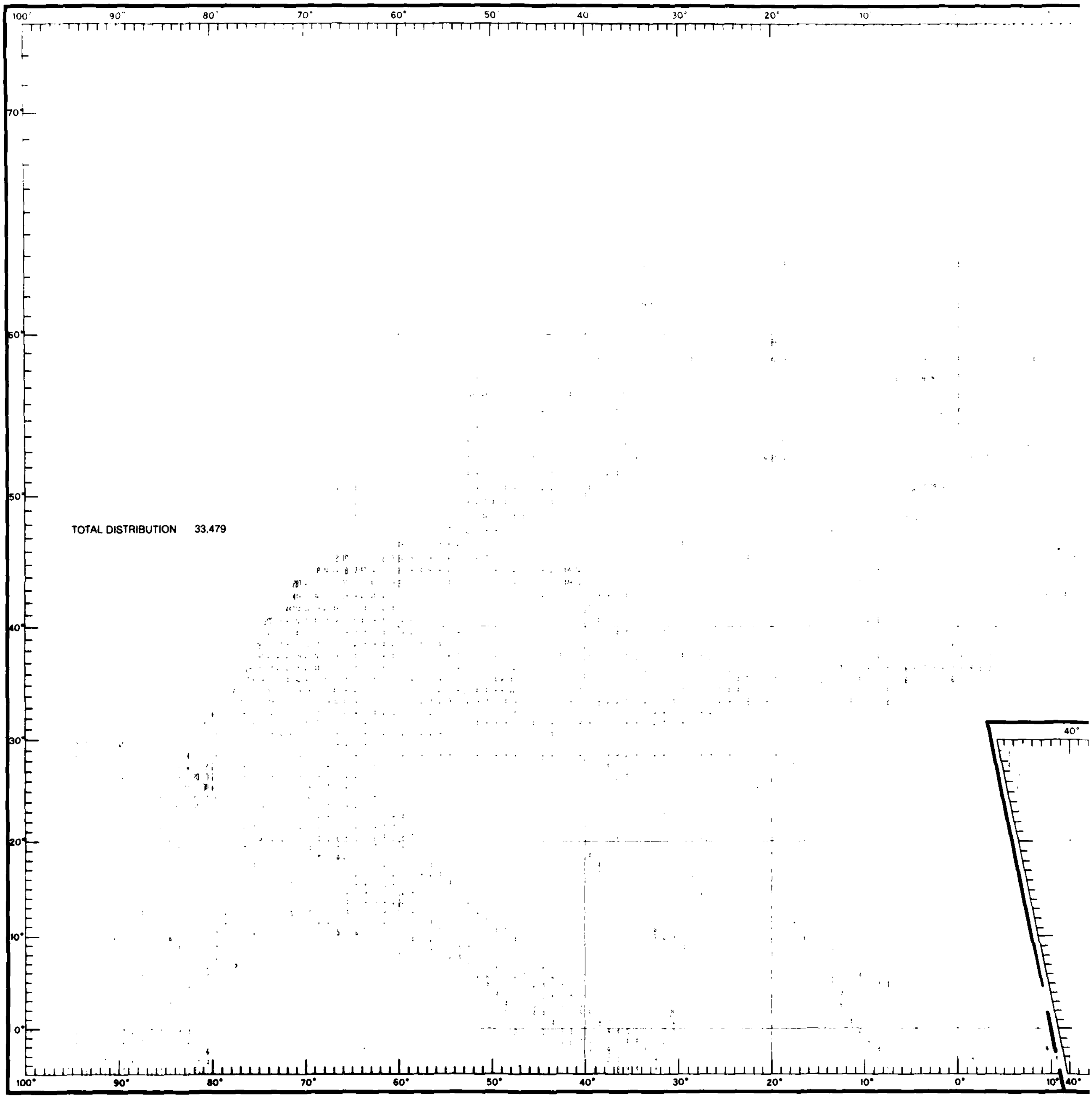
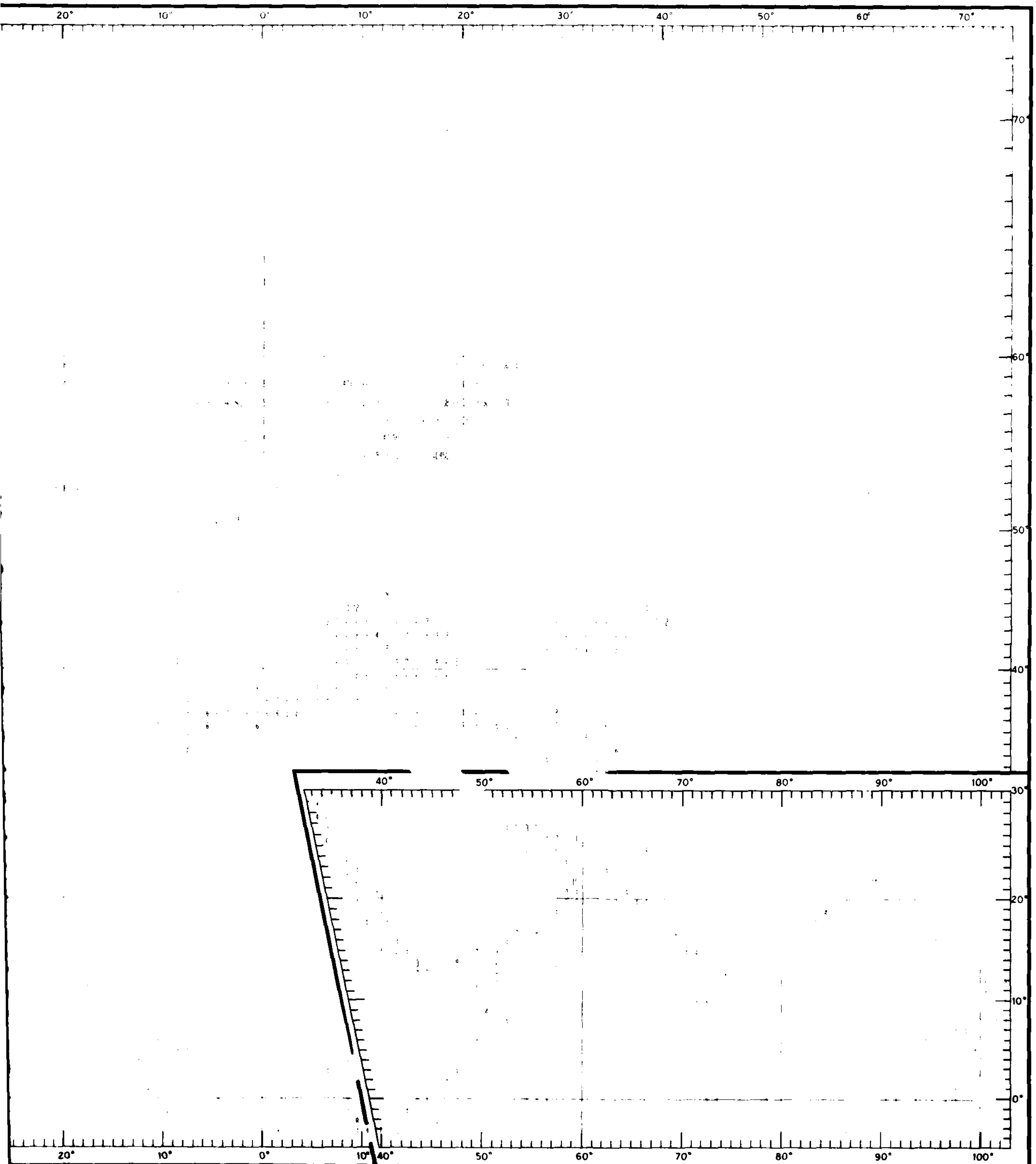


FIGURE 155. DECEMBER DATA DISTRIBUTION OF TEMPERATURES AT THE SURF



ATA DISTRIBUTION OF TEMPERATURES AT THE SURFACE

1 2

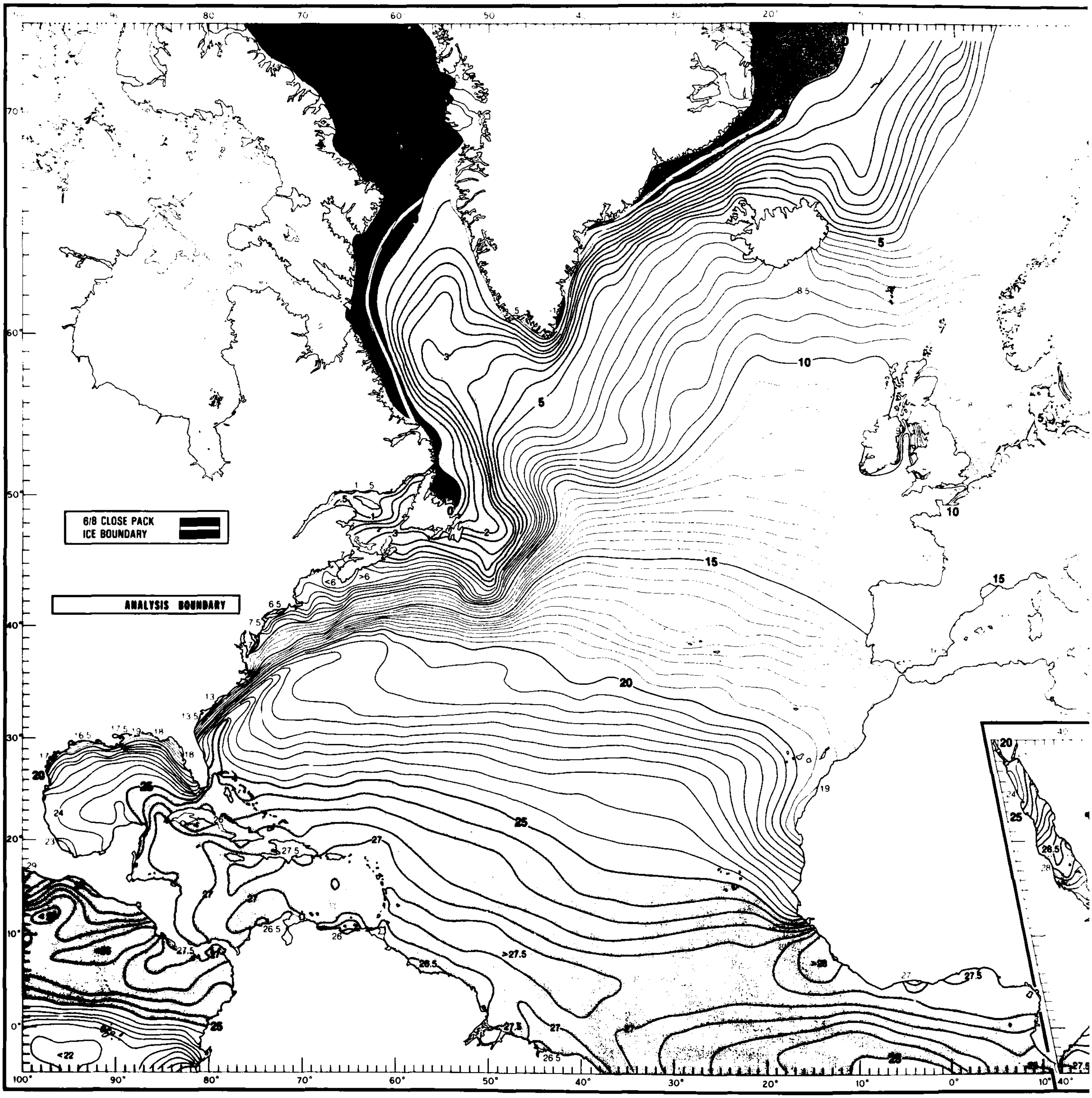
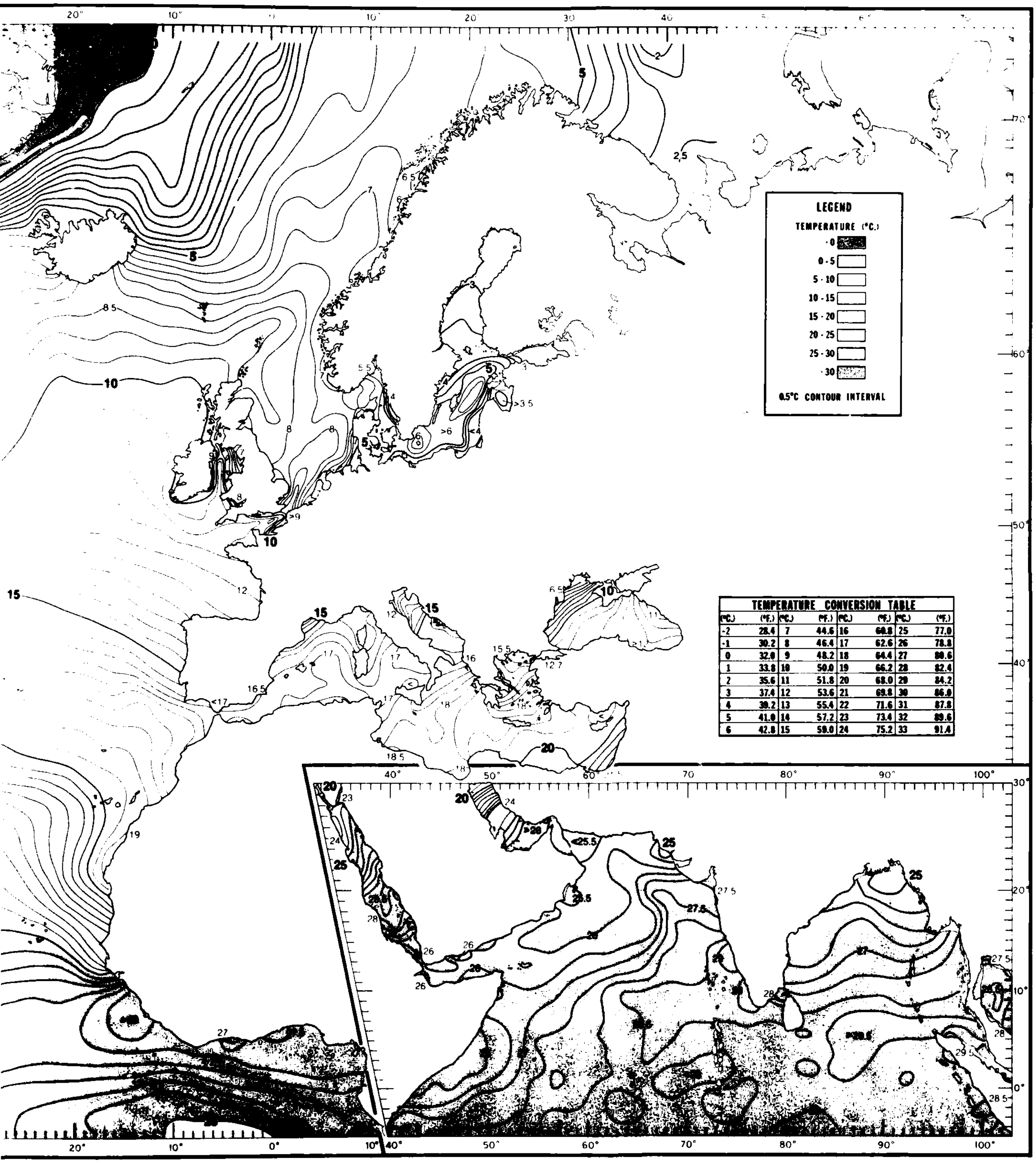


FIGURE 156. DECEMBER MEAN TEMPERATURES AT THE SURFACE



TEMPERATURE CONVERSION TABLE

(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

:EMBER MEAN TEMPERATURES AT THE SURFACE

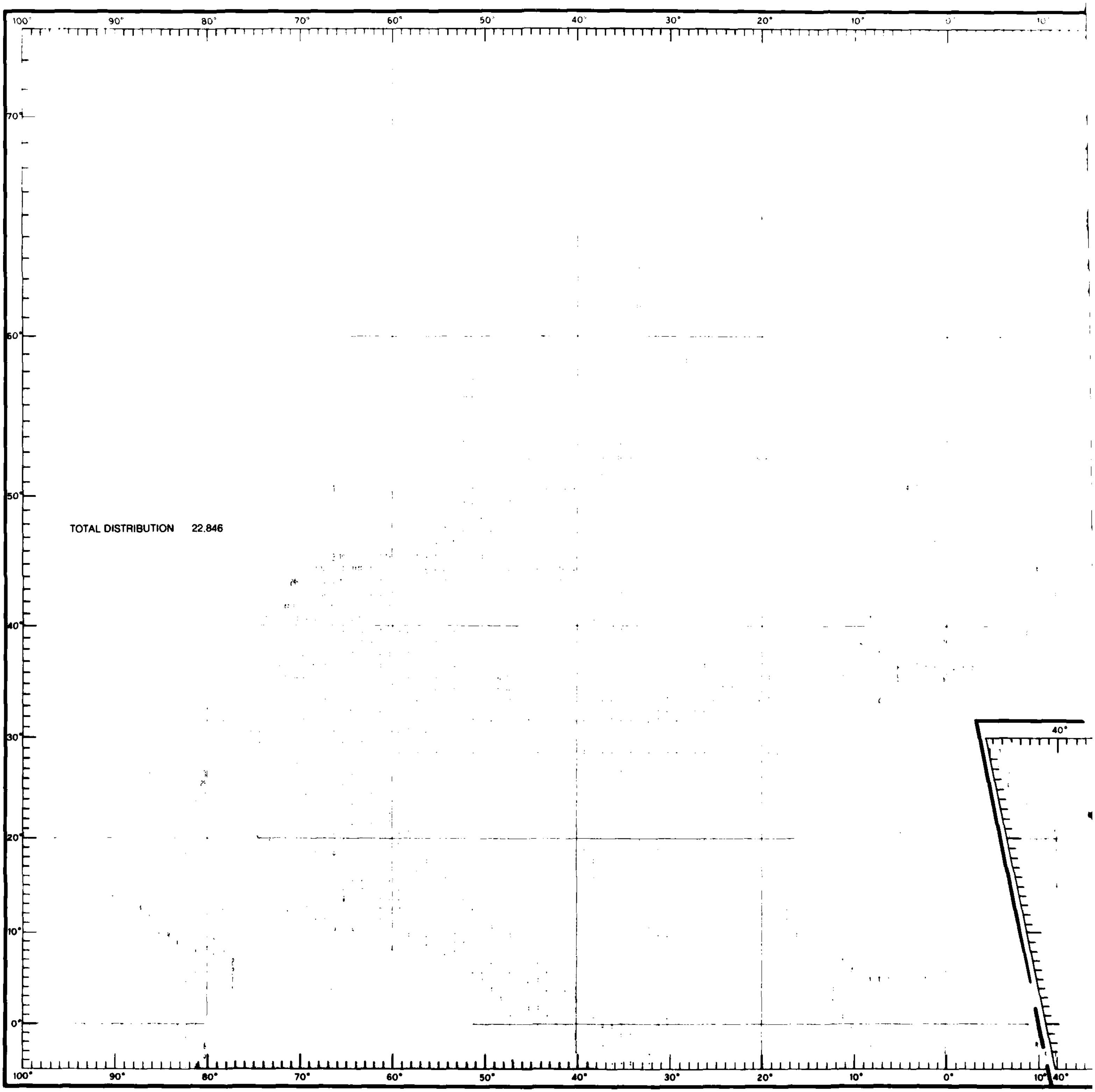
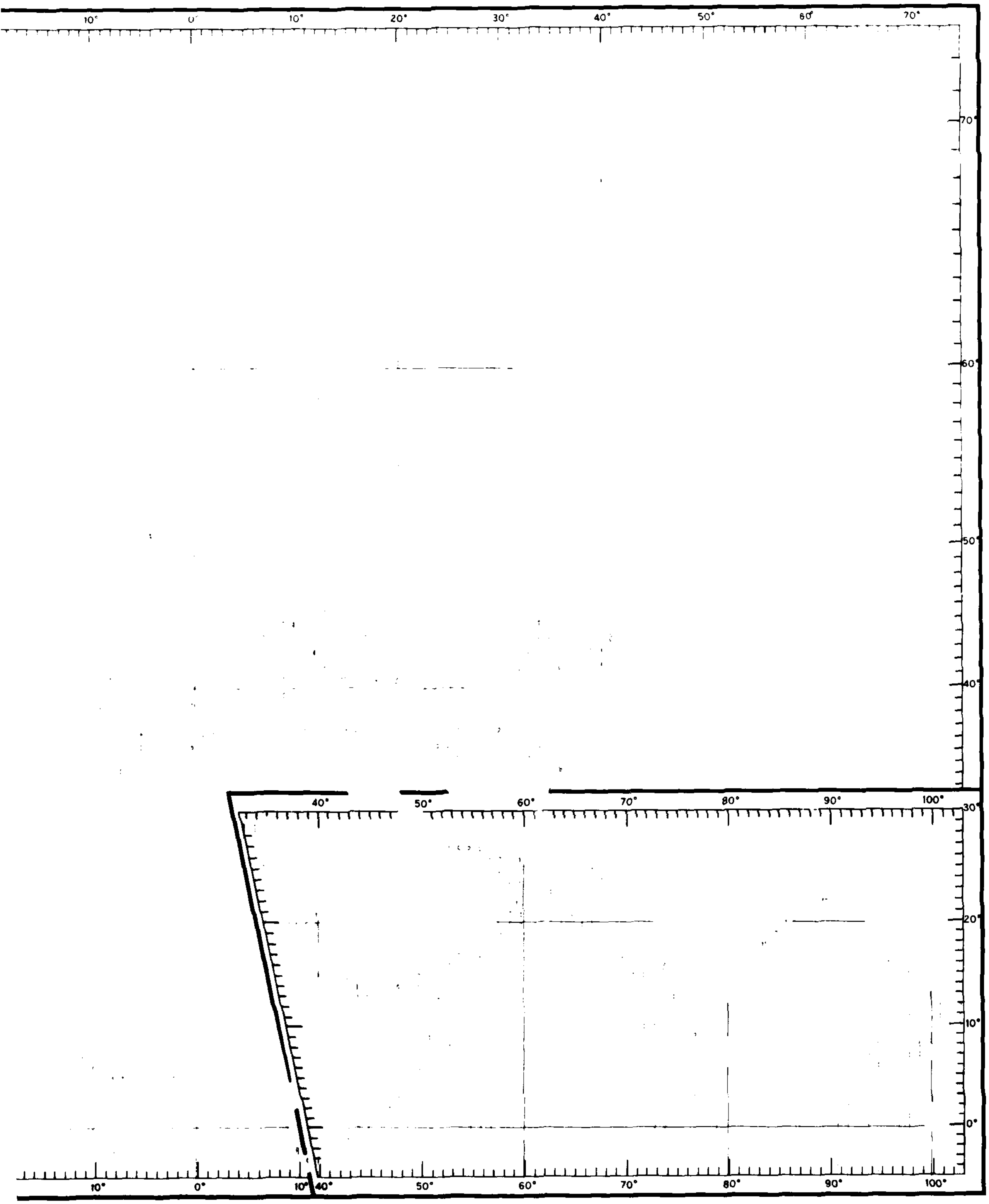


FIGURE 157. DECEMBER DATA DISTRIBUTION OF TEMPERATURES AT 100 FT (30 M



RIBUTION OF TEMPERATURES AT 100 FT (30 M)

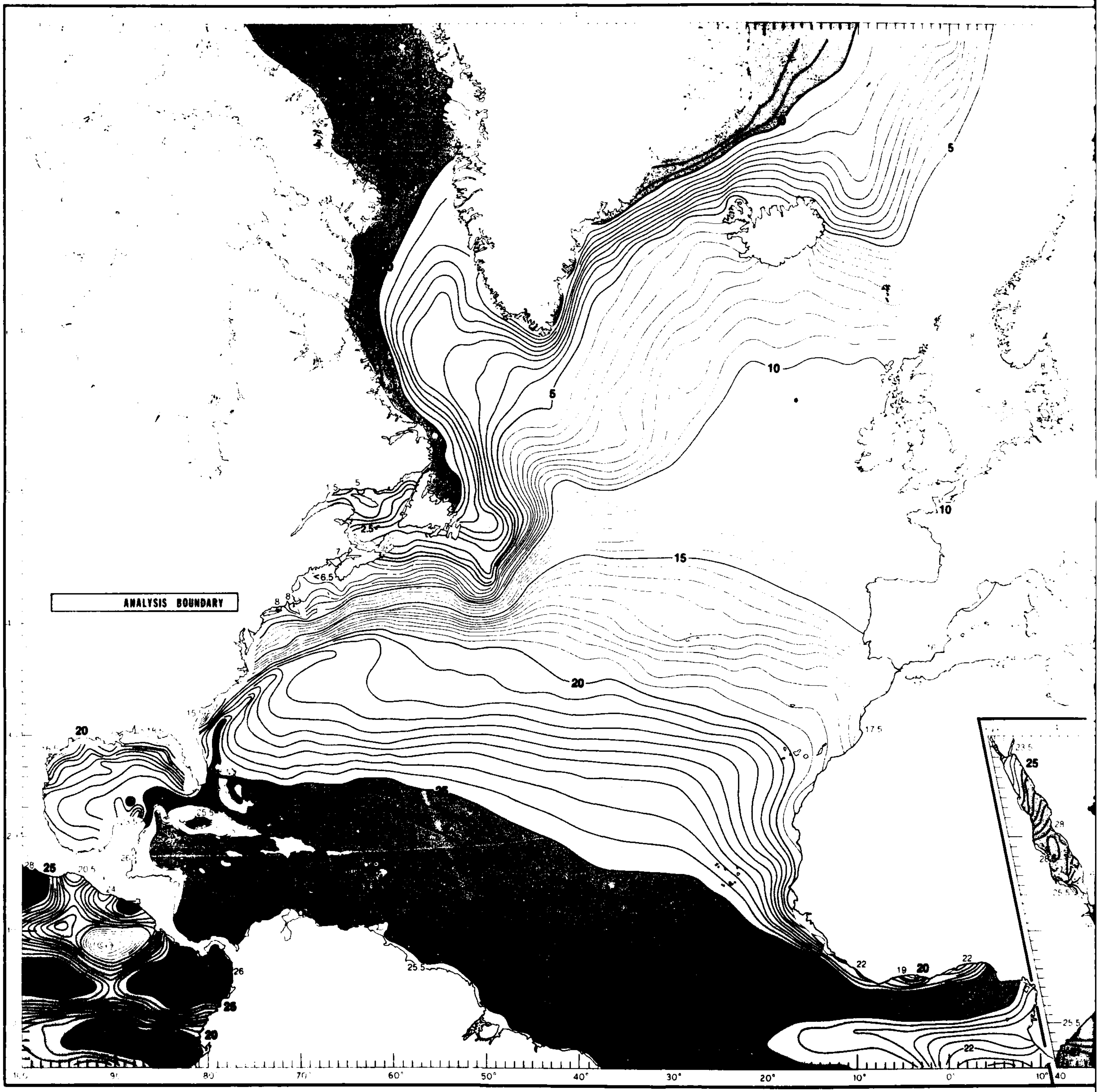
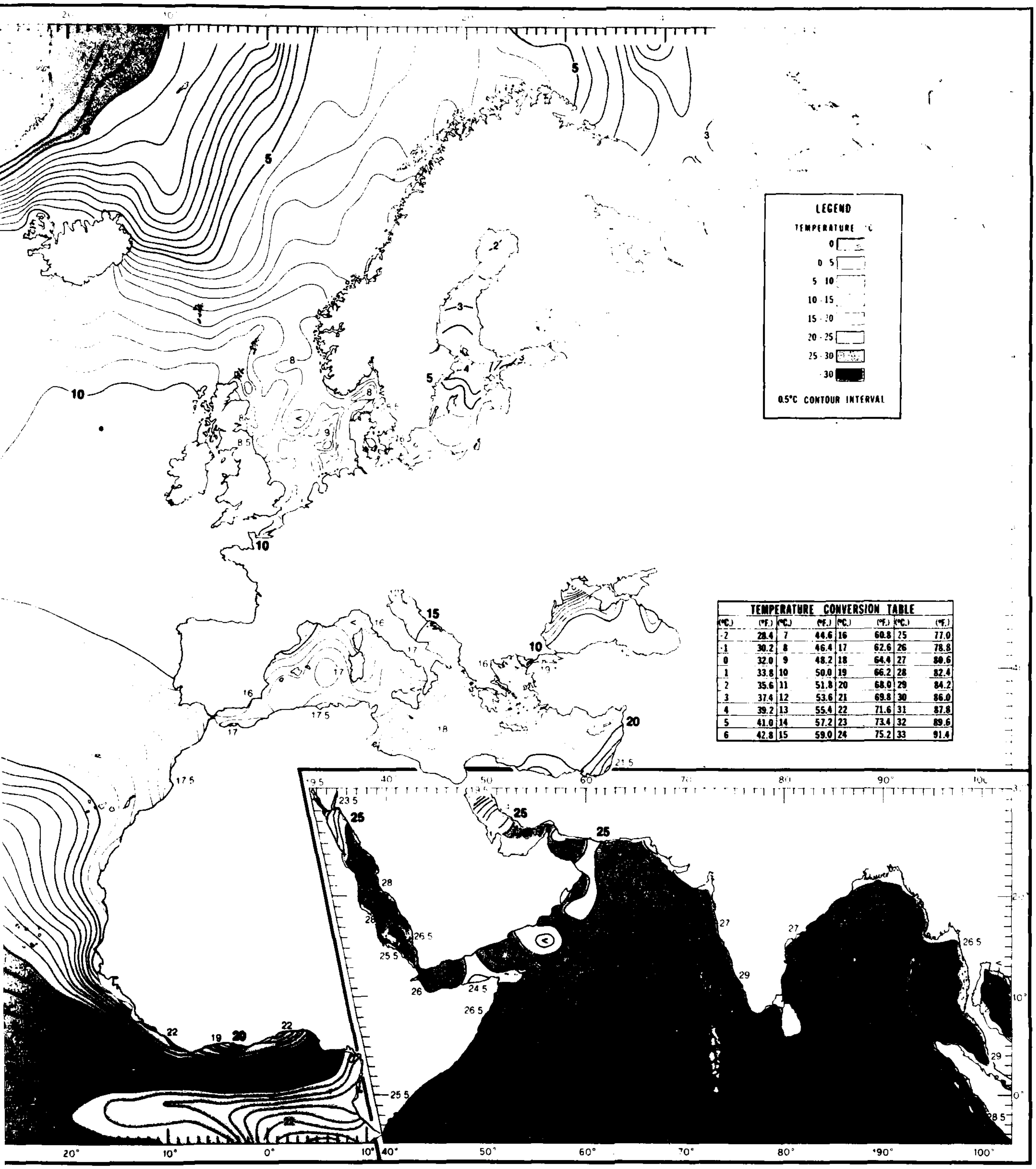


FIGURE 158. DECEMBER MEAN TEMPERATURES AT 100 FT (30 M)



TEMPERATURE CONVERSION TABLE							
(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

MBER MEAN TEMPERATURES AT 100 FT (30 M)

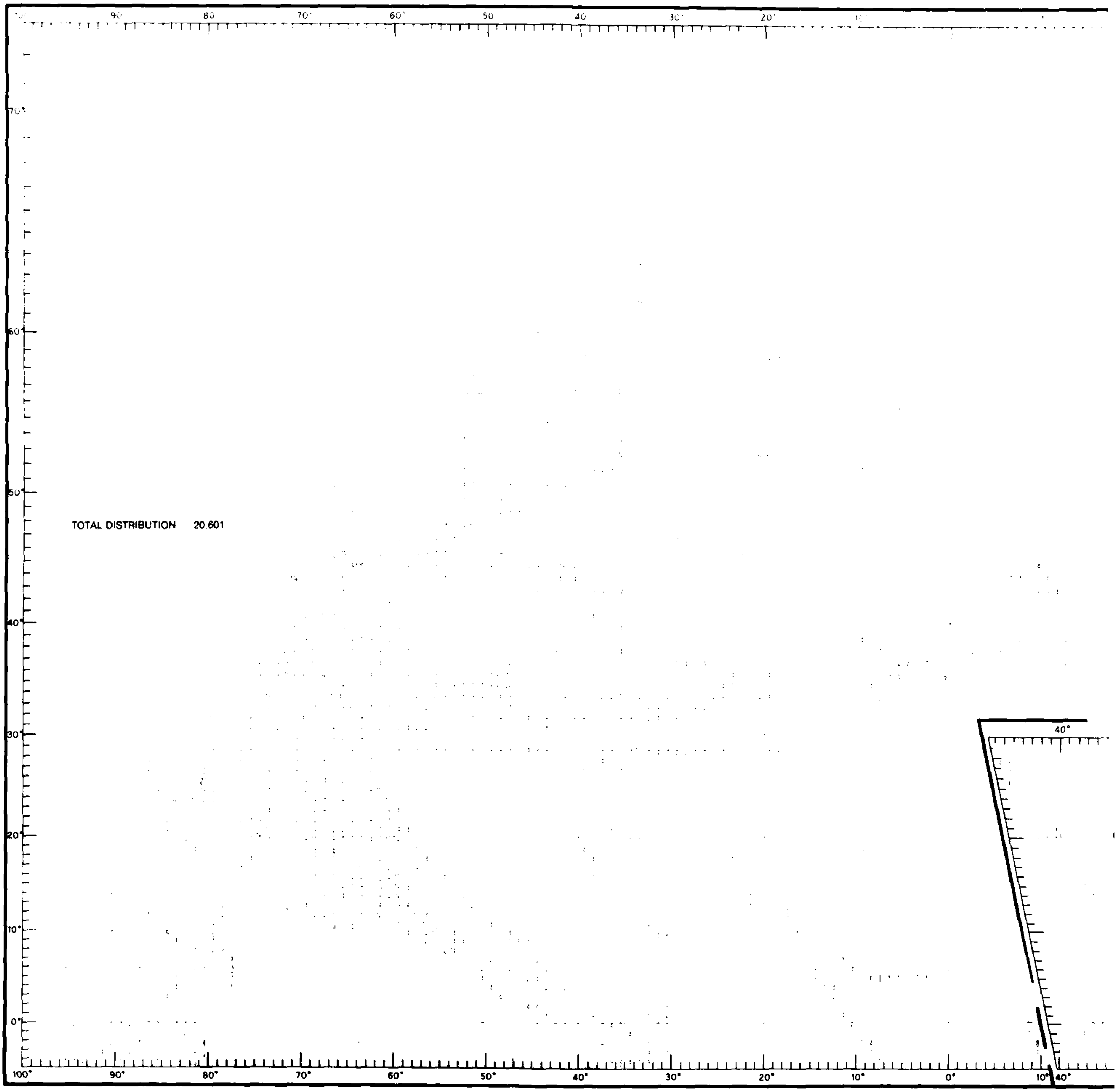
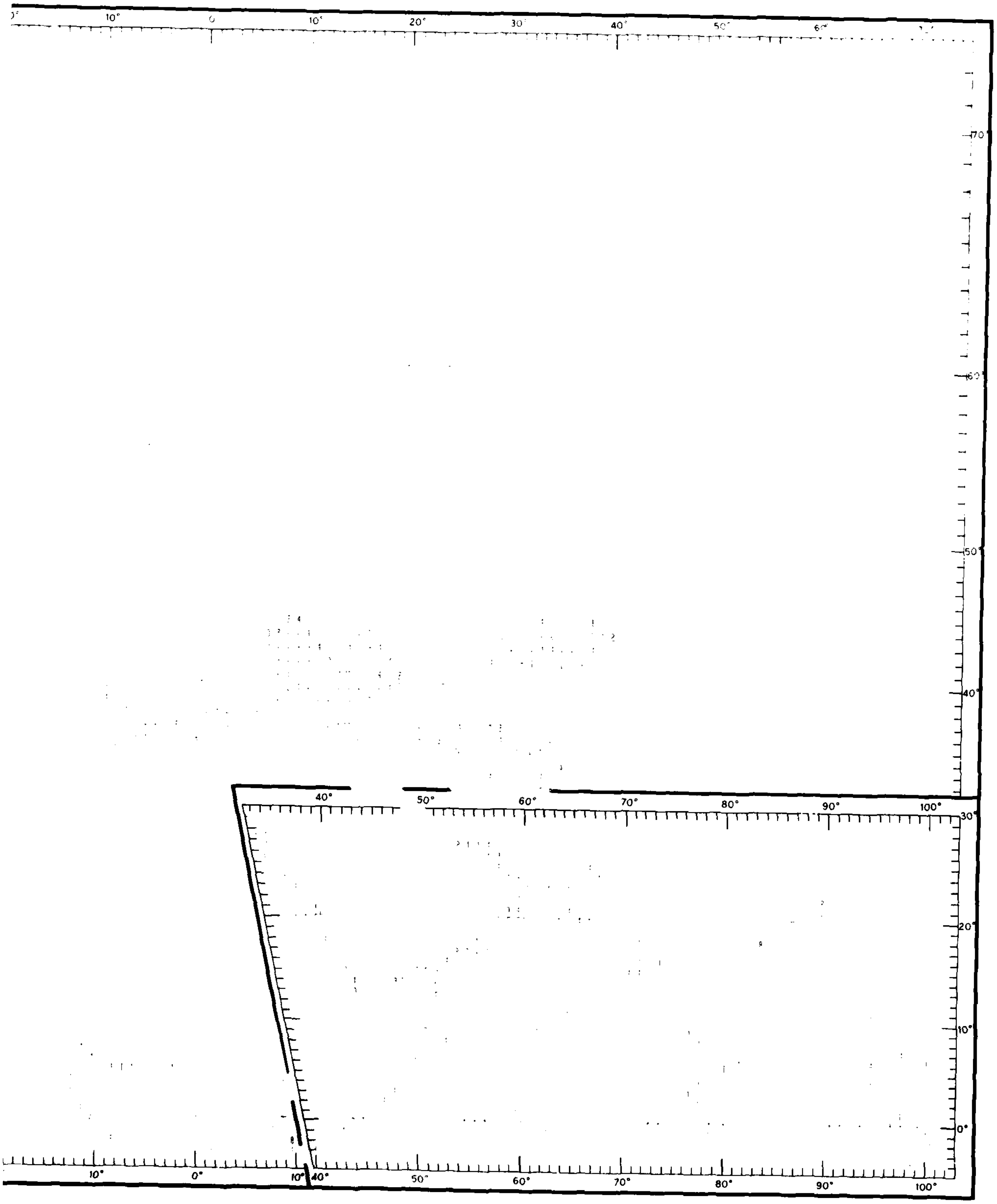


FIGURE 159. DECEMBER DATA DISTRIBUTION OF TEMPERATURES AT 200 FT (60 M)



TRIBUTION OF TEMPERATURES AT 200 FT (60 M)

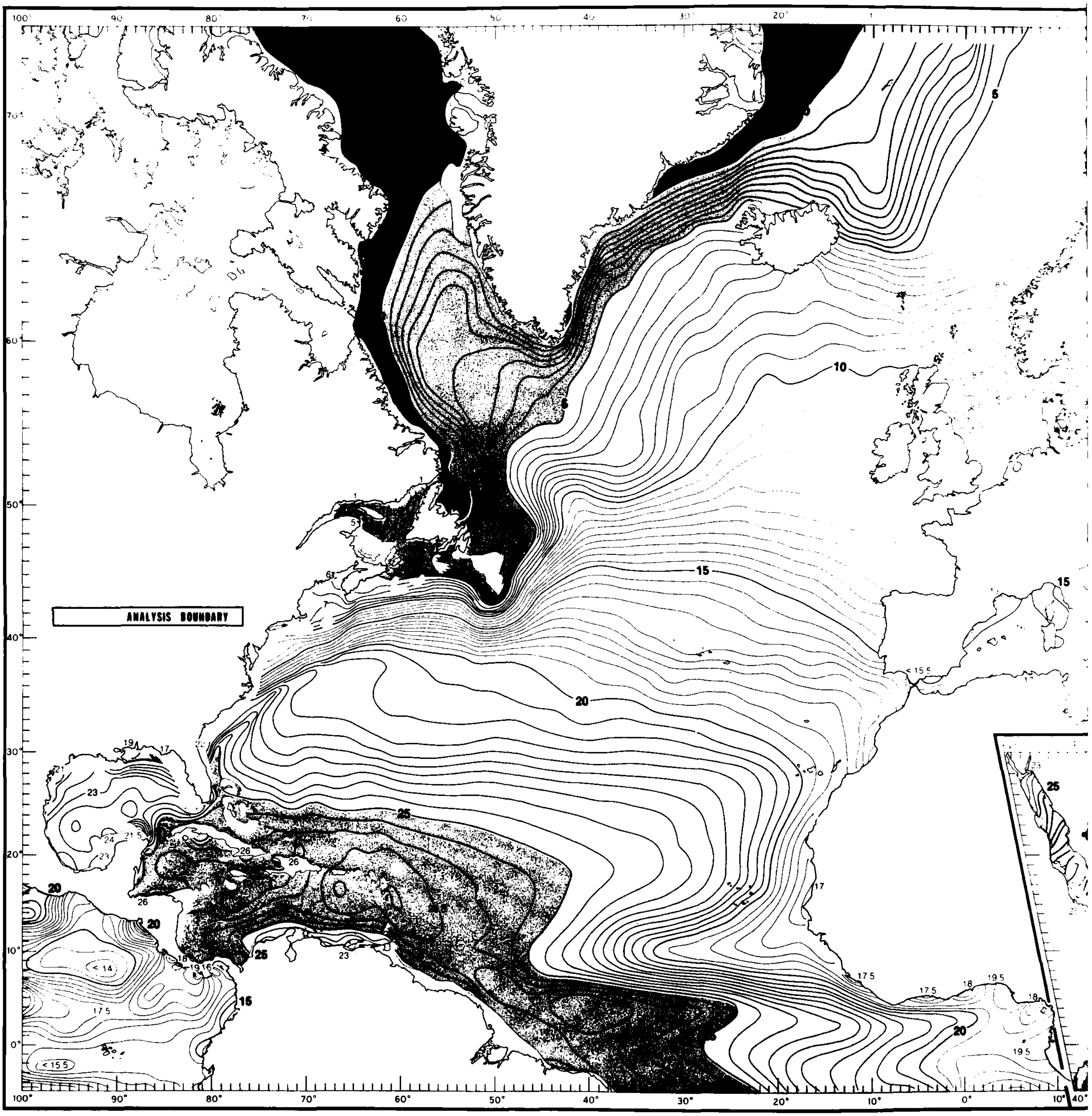
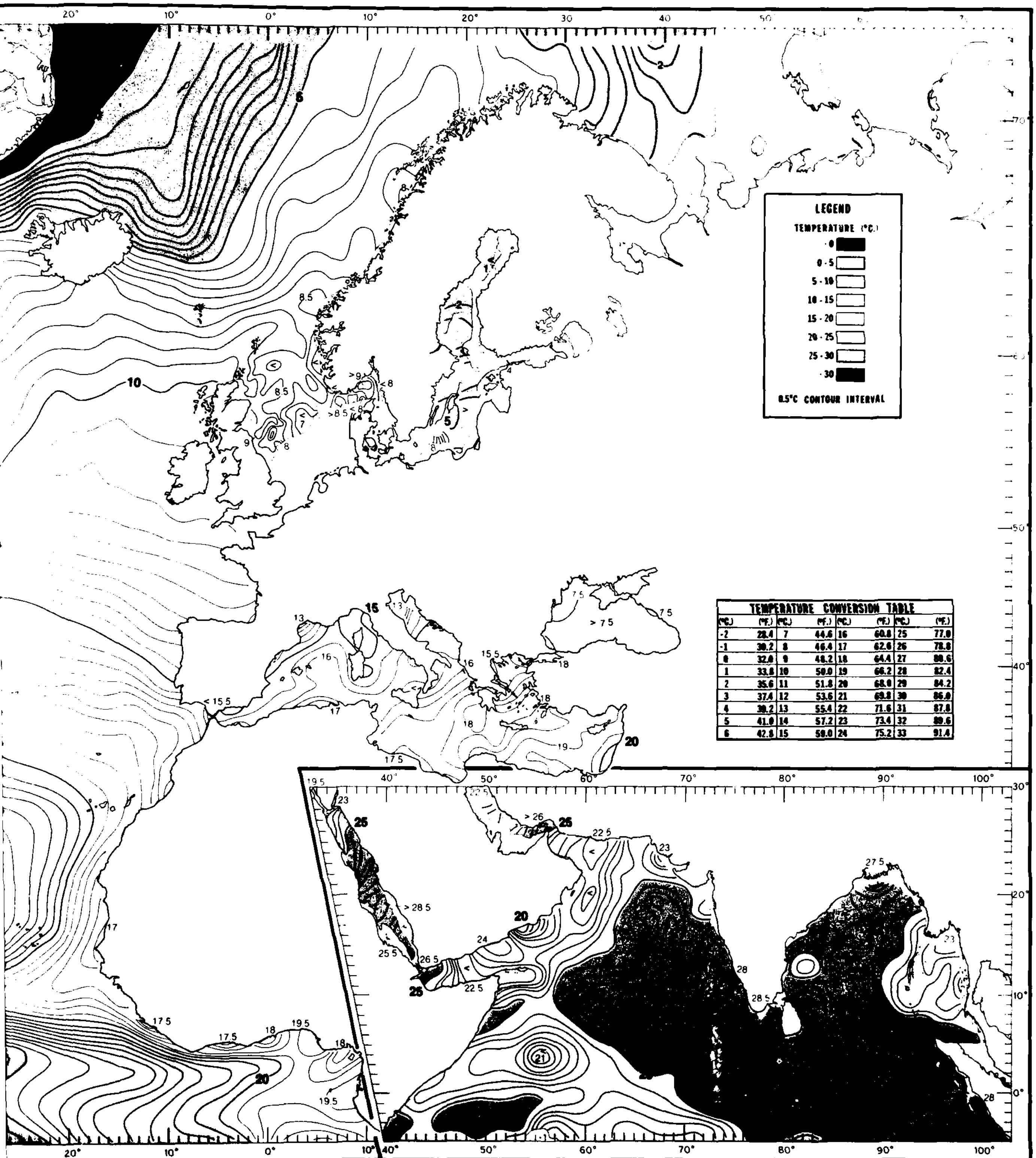


FIGURE 160. DECEMBER MEAN TEMPERATURES AT 200 FT (60 M)



TEMPERATURE CONVERSION TABLE							
(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

EMBER MEAN TEMPERATURES AT 200 FT (60 M)

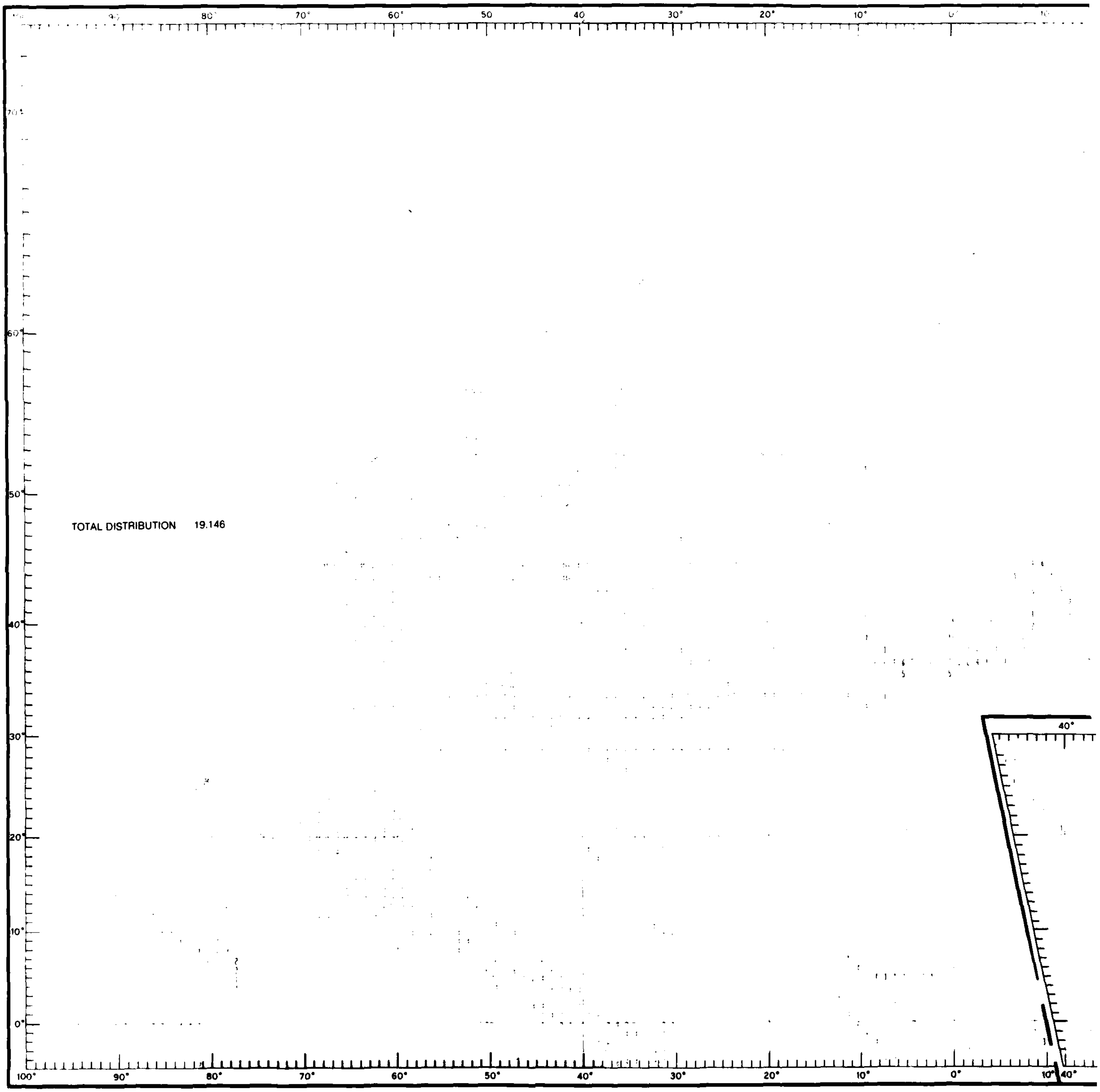
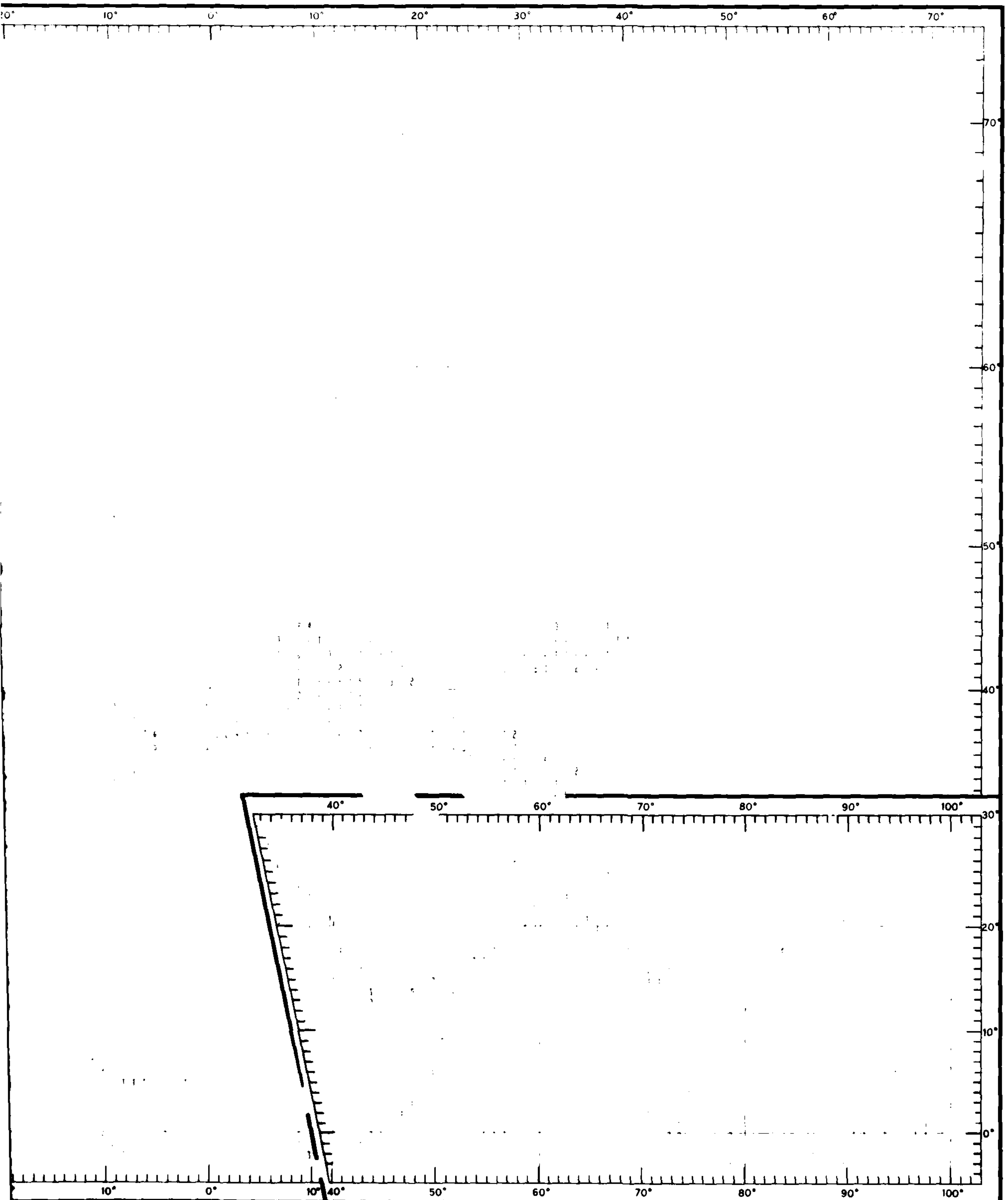


FIGURE 161. DECEMBER DATA DISTRIBUTION OF TEMPERATURES AT 300 FT (90



TRIBUTION OF TEMPERATURES AT 300 FT (90 M)

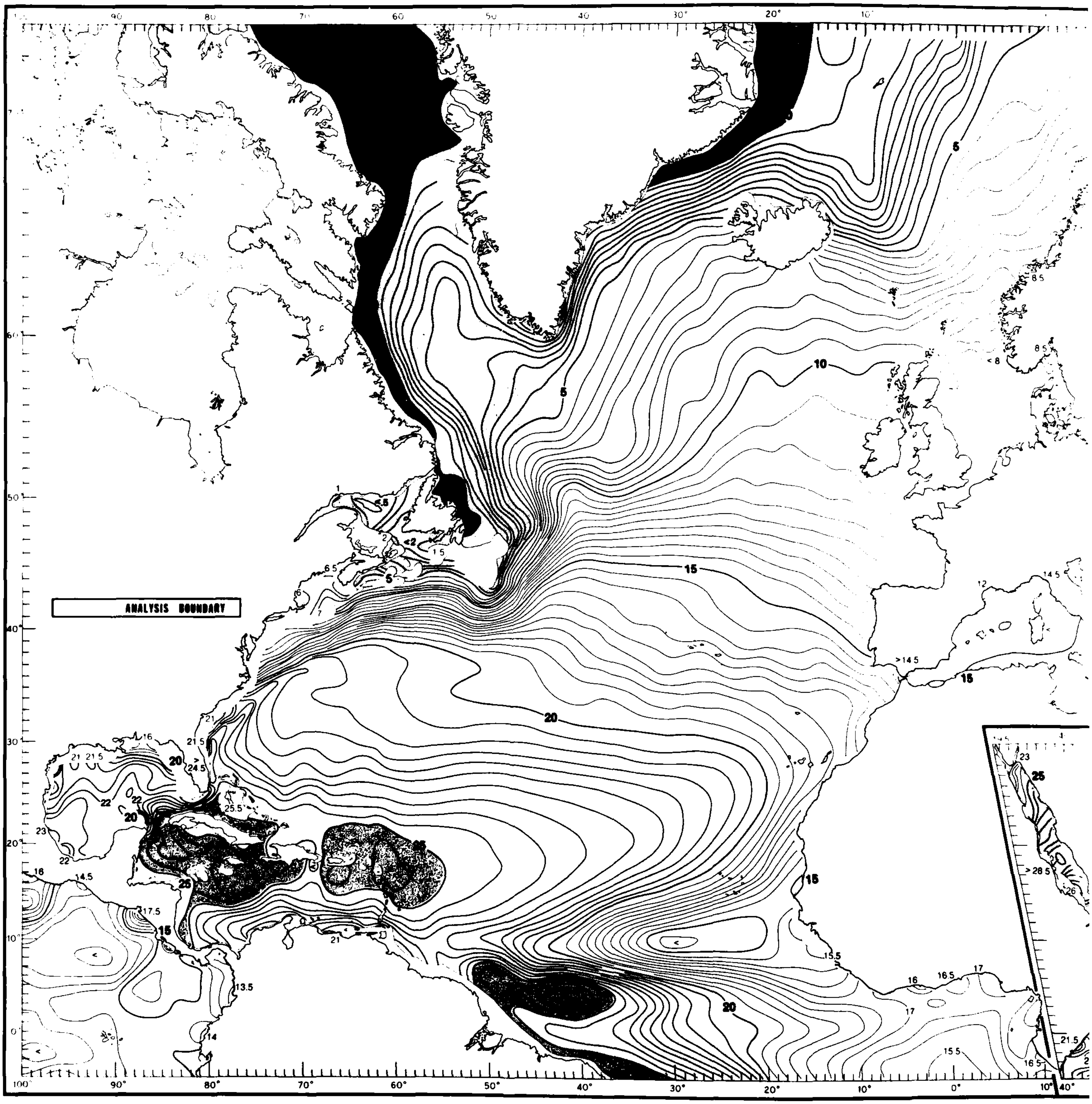
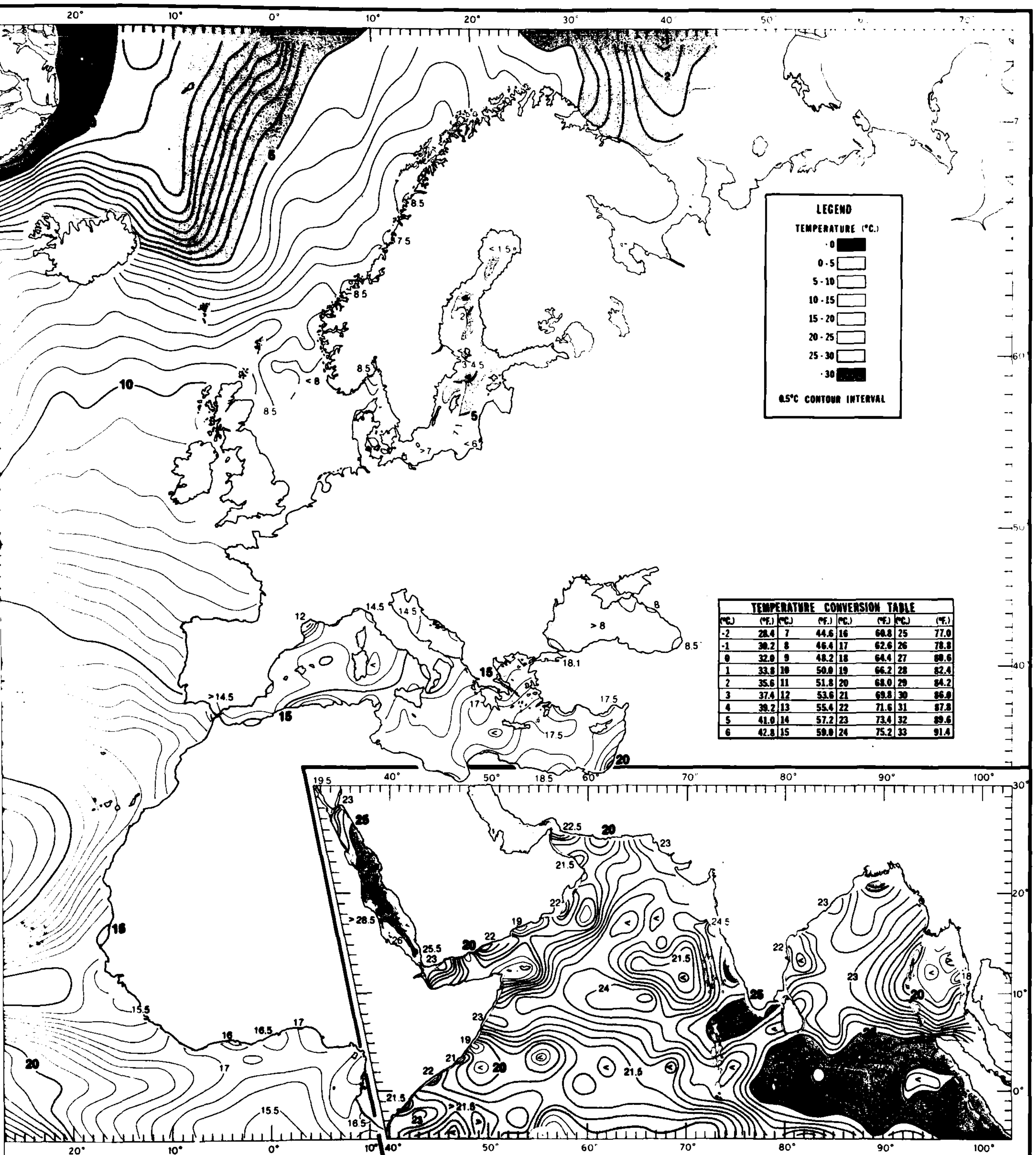


FIGURE 162. DECEMBER MEAN TEMPERATURES AT 300 FT (90 M)



TEMPERATURE CONVERSION TABLE							
(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

ECEMBER MEAN TEMPERATURES AT 300 FT (90 M)

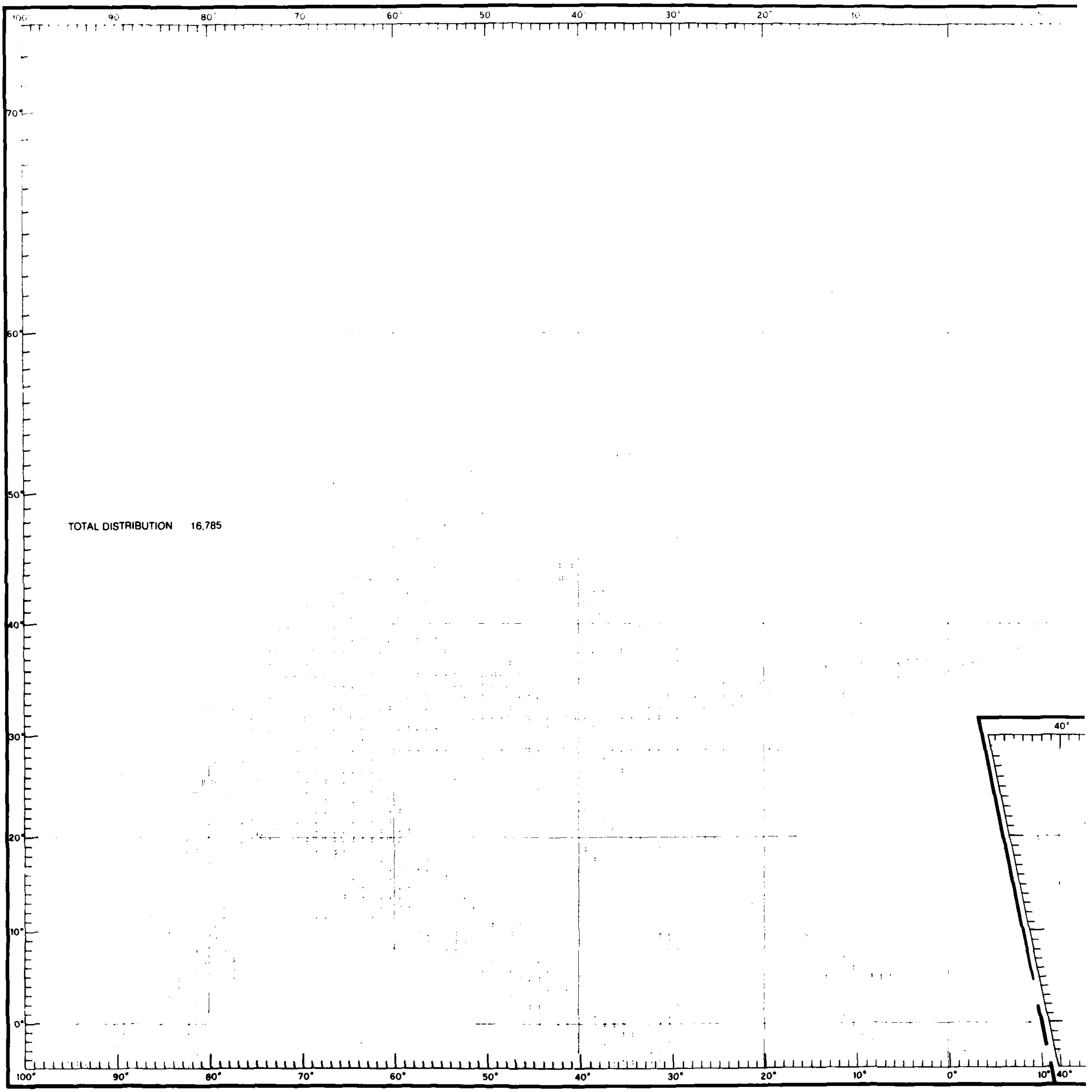
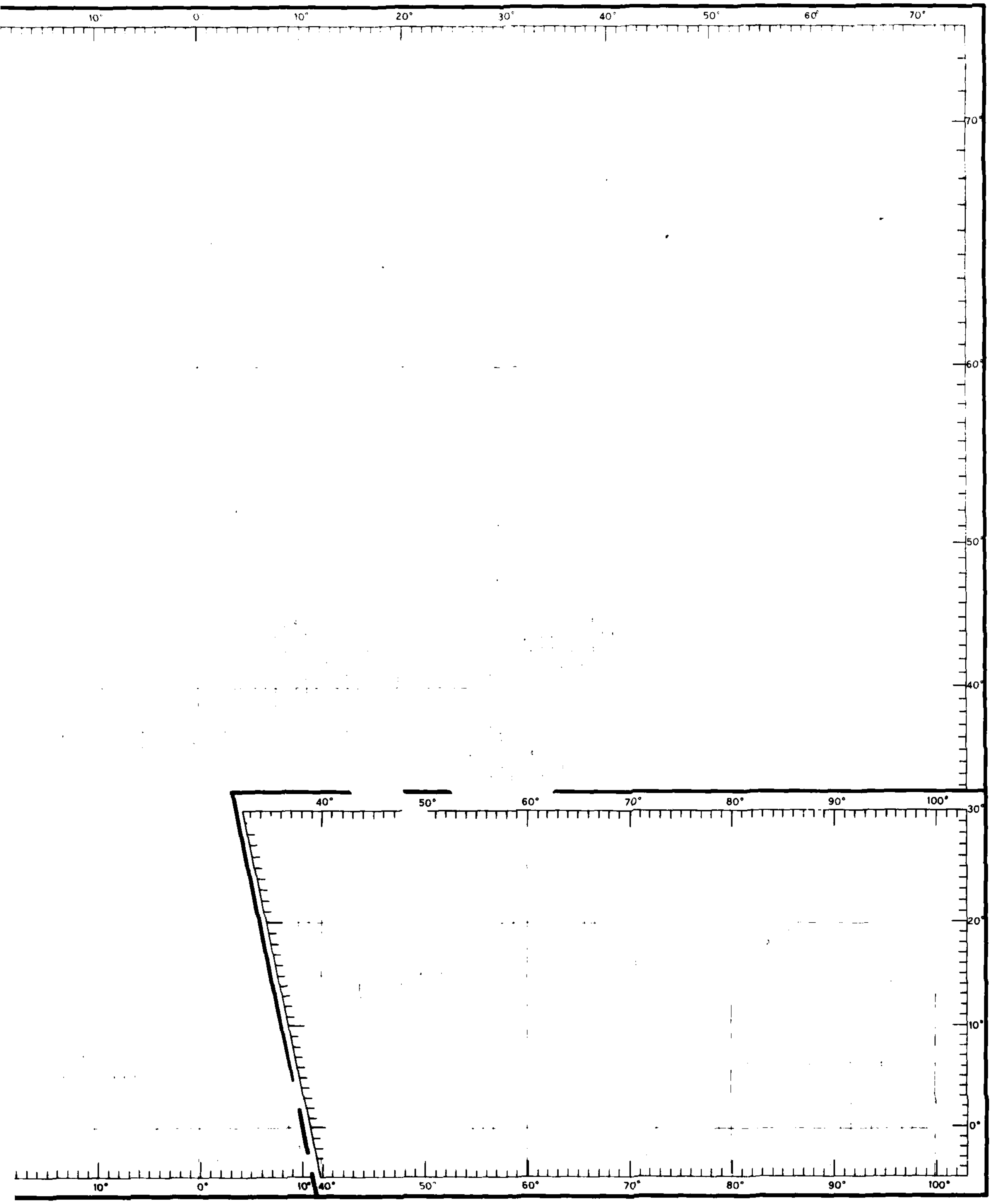


FIGURE 163. DECEMBER DATA DISTRIBUTION OF TEMPERATURES AT 400 FT (120



RIBUTION OF TEMPERATURES AT 400 FT (120 M)

2

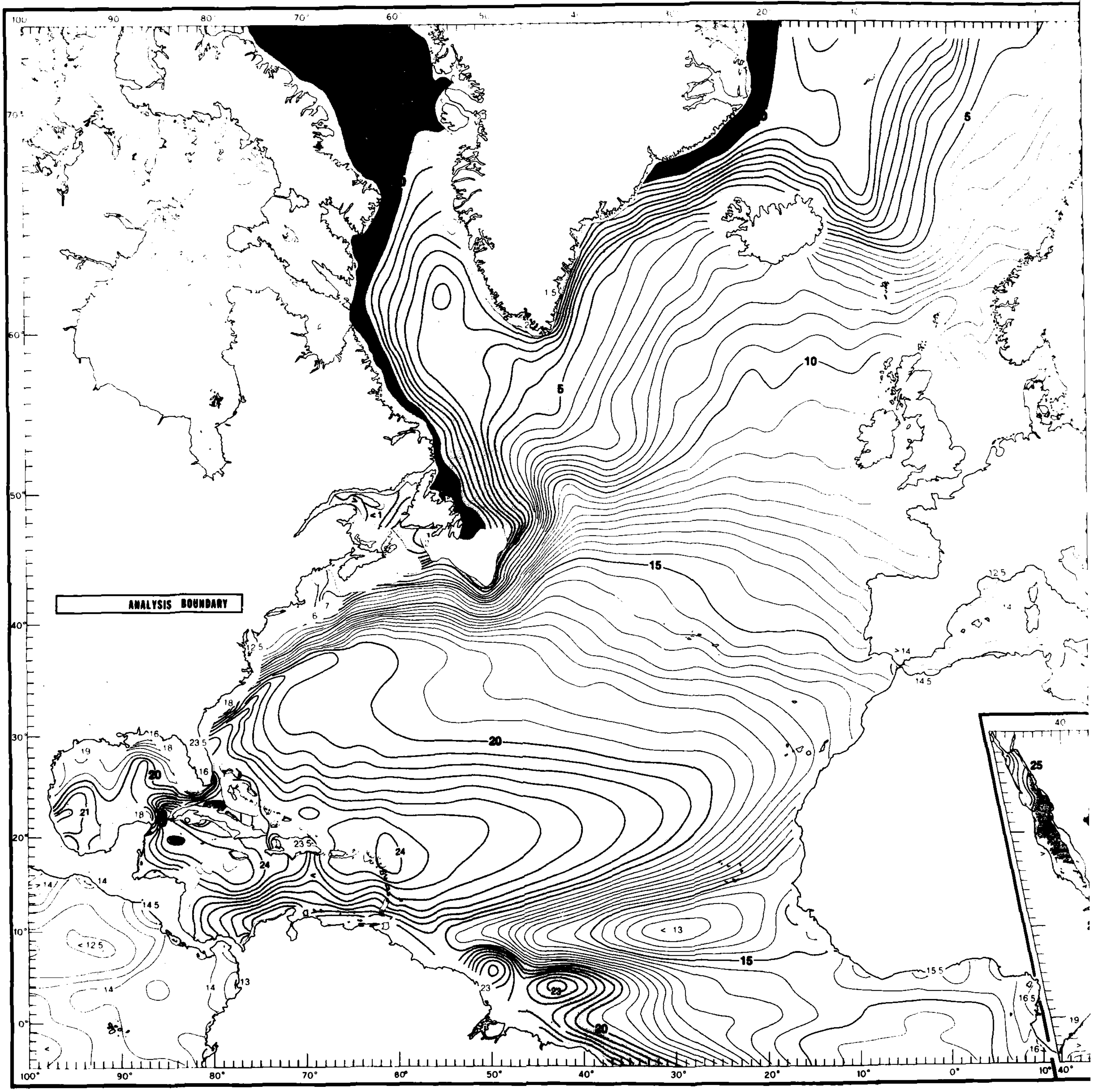
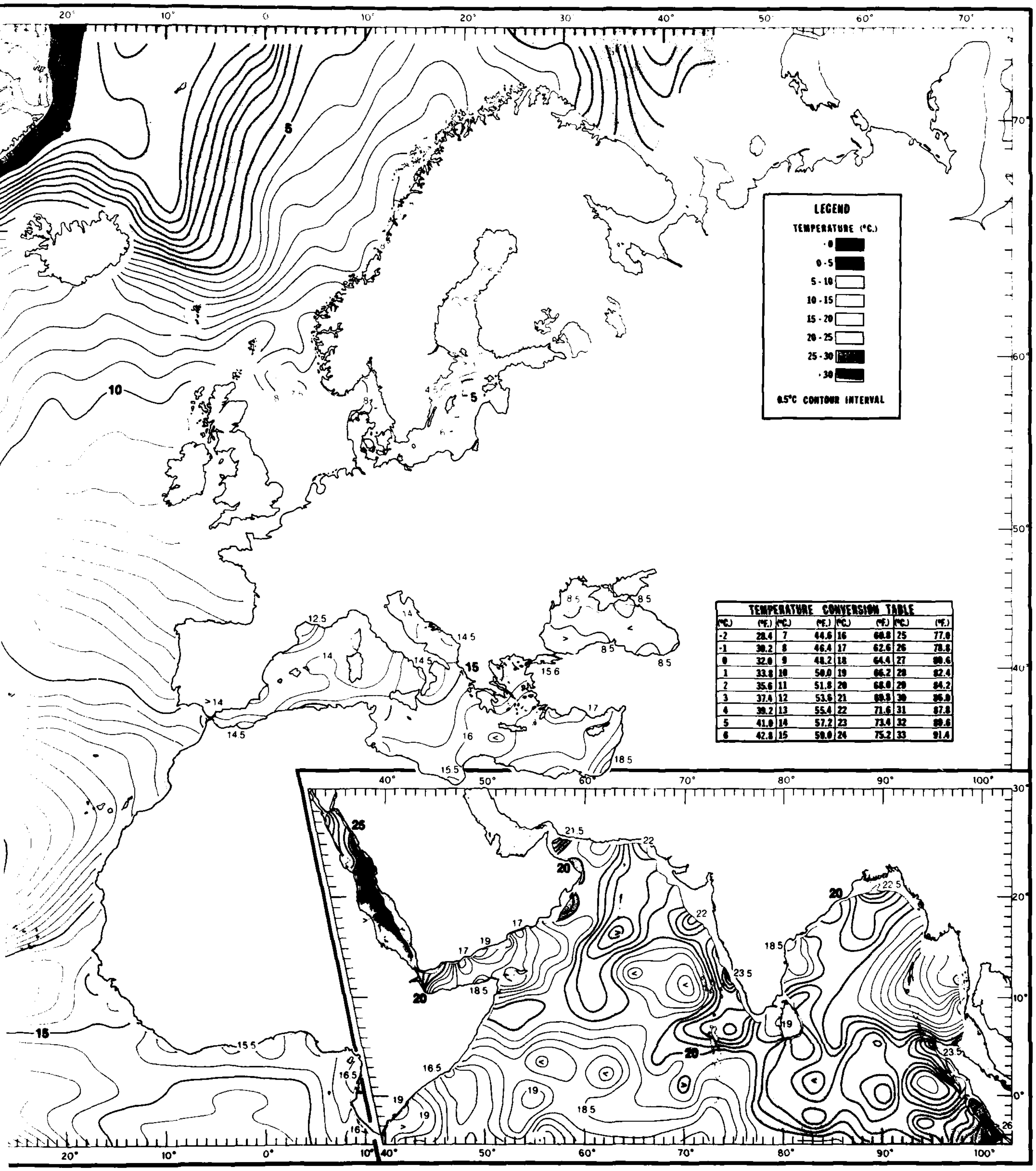


FIGURE 164. DECEMBER MEAN TEMPERATURES AT 400 FT (120 M)



TEMPERATURE CONVERSION TABLE							
(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

ER MEAN TEMPERATURES AT 400 FT (120 M)

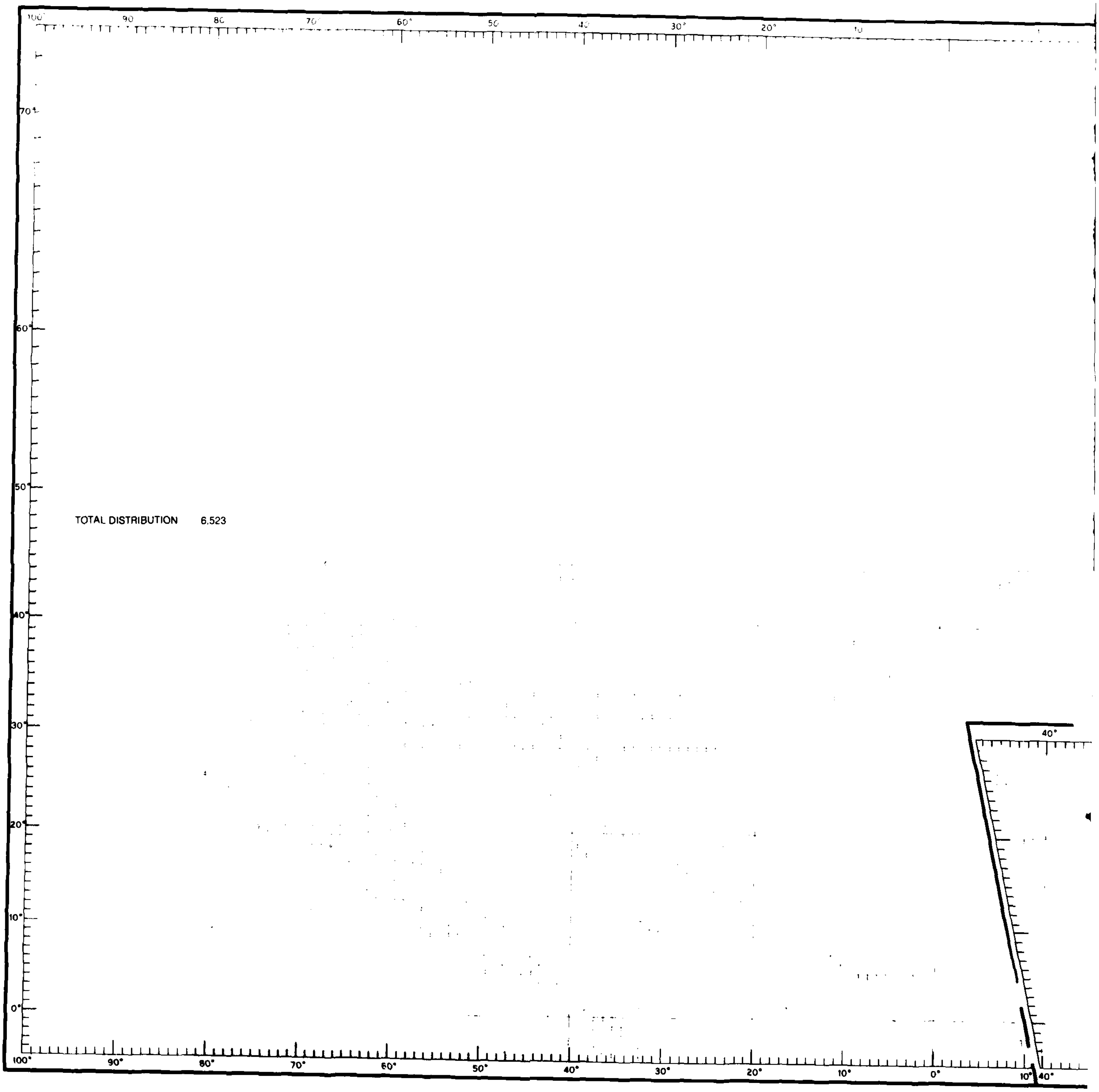
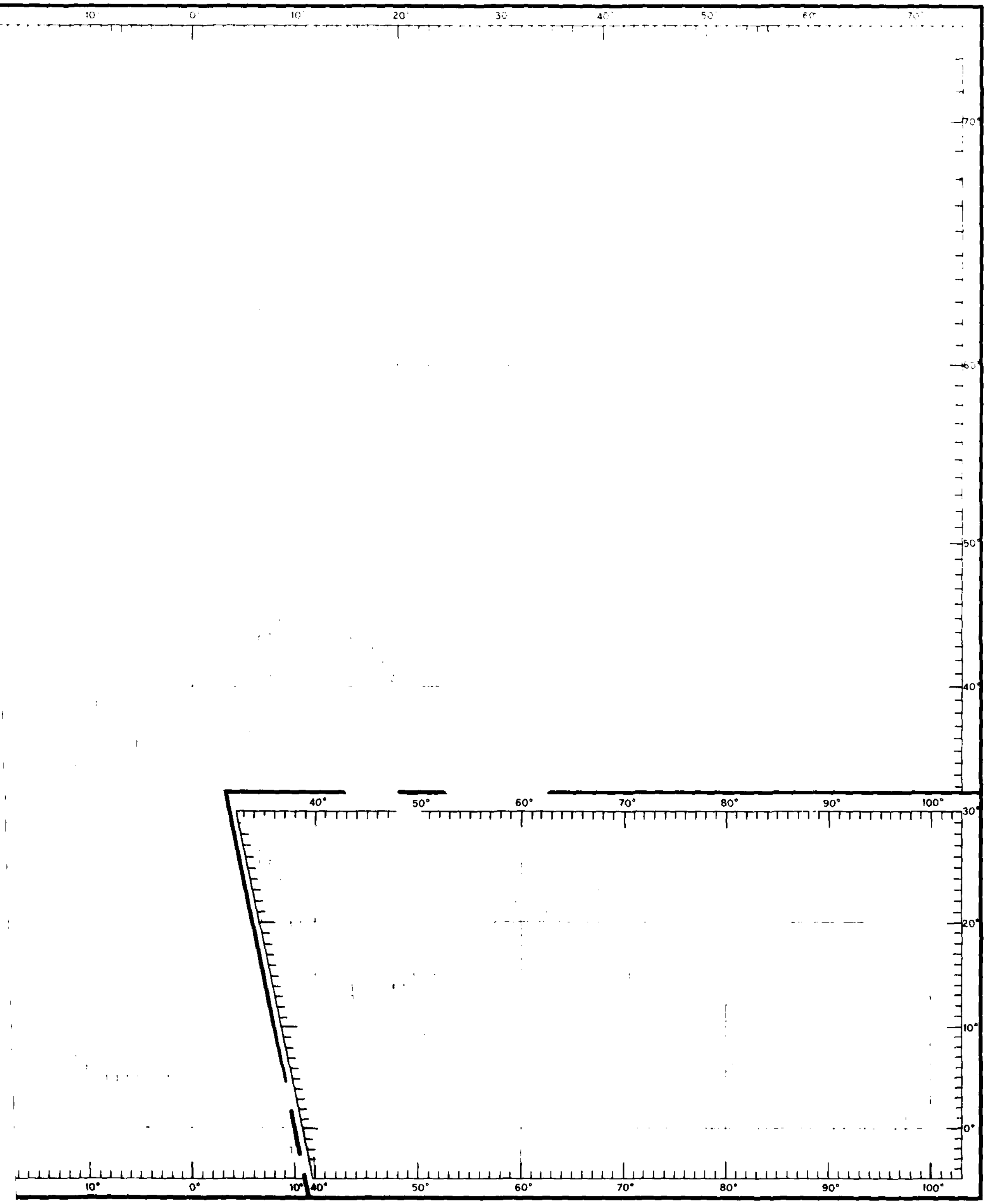


FIGURE 165. DECEMBER DATA DISTRIBUTION OF TEMPERATURES AT 492 FT (150 M



IBUTION OF TEMPERATURES AT 492 FT (150 M)

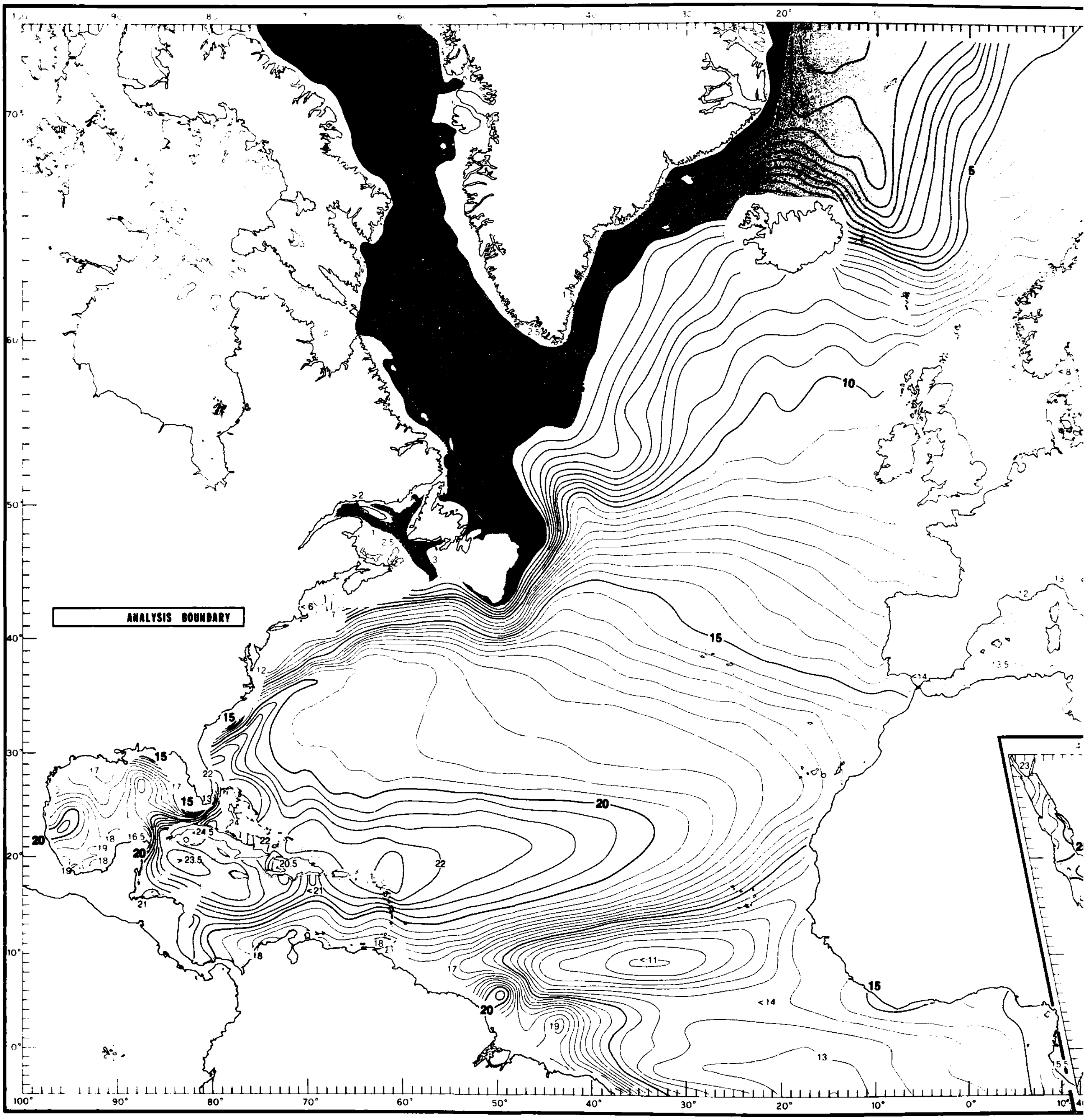
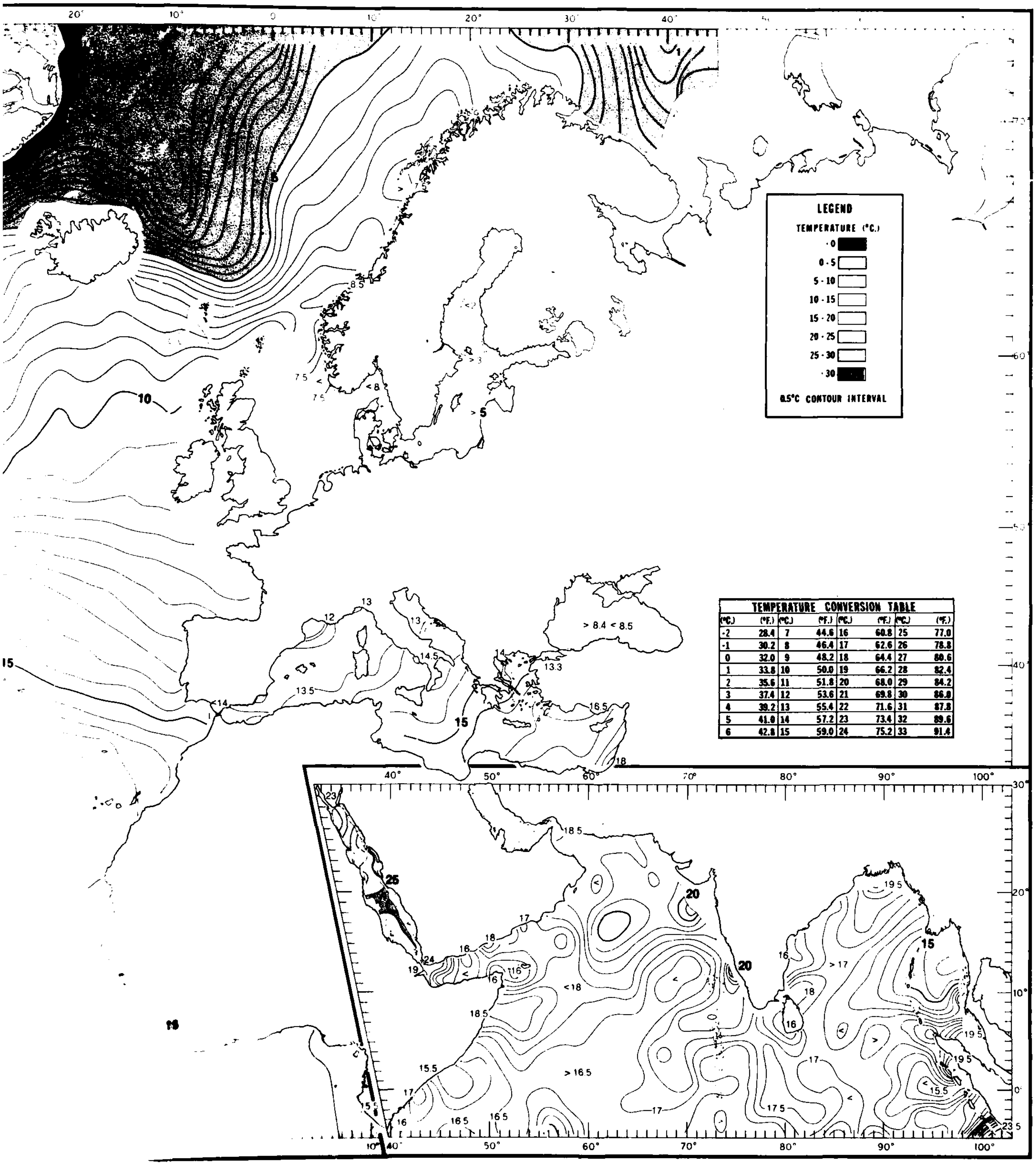


FIGURE 166. DECEMBER MEAN TEMPERATURES AT 492 FT (150 M)



TEMPERATURE CONVERSION TABLE

(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

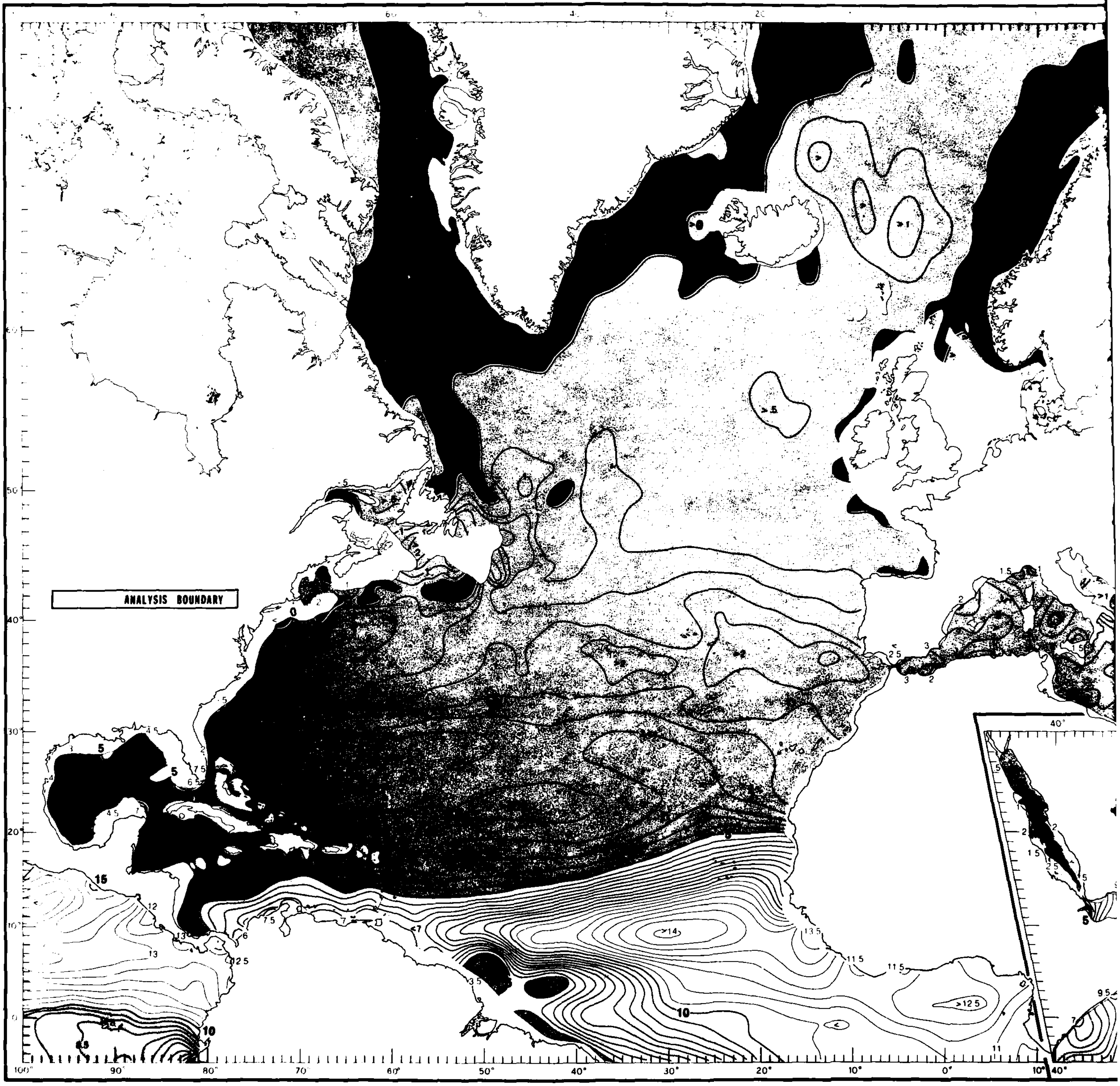
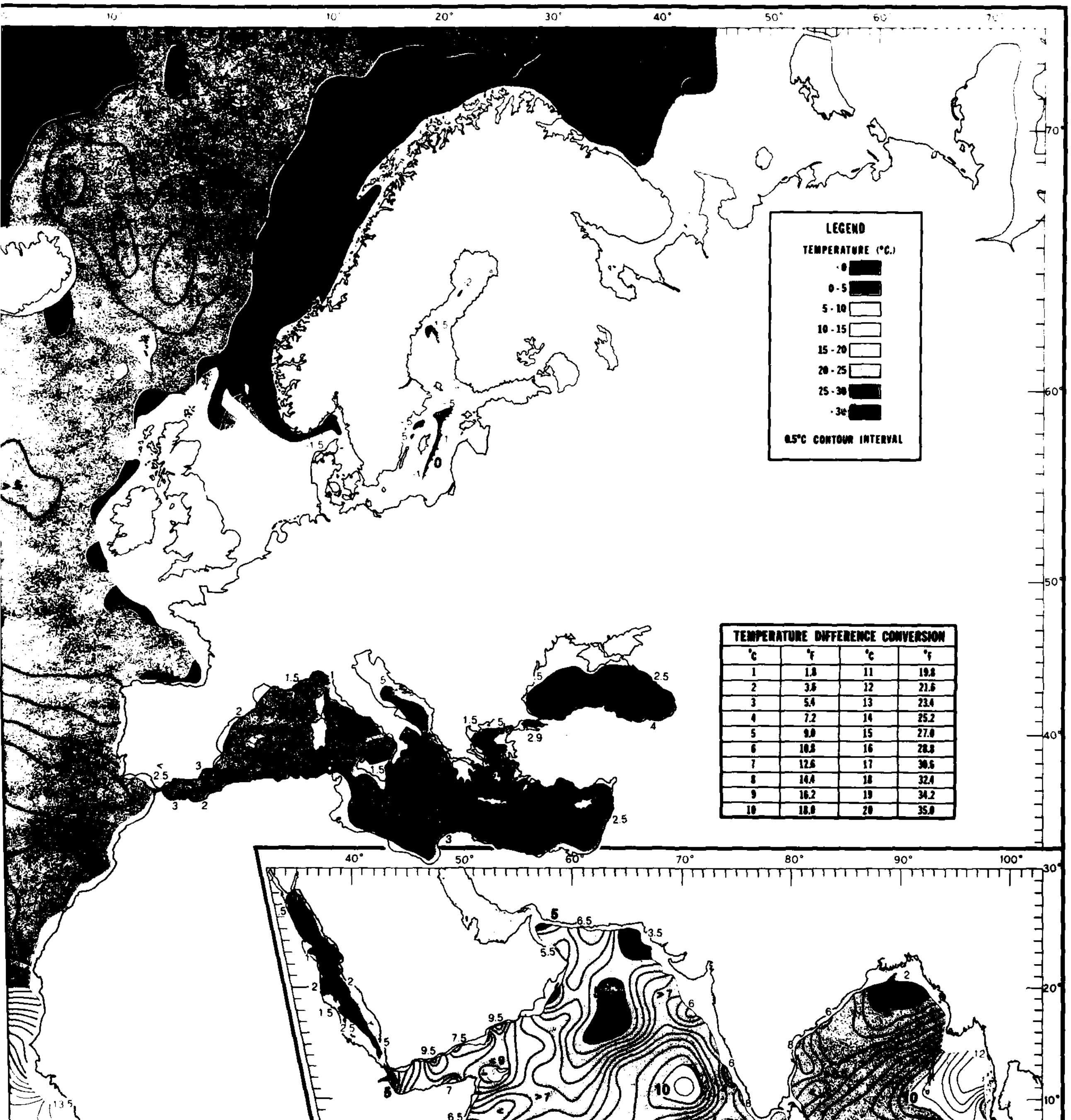


FIGURE 167. DECEMBER TEMPERATURE DIFFERENCE BETWEEN THE SURFACE AND 400 FT (T_0



TEMPERATURE DIFFERENCE CONVERSION			
°C	°F	°C	°F
1	1.8	11	19.8
2	3.6	12	21.6
3	5.4	13	23.4
4	7.2	14	25.2
5	9.0	15	27.0
6	10.8	16	28.8
7	12.6	17	30.6
8	14.4	18	32.4
9	16.2	19	34.2
10	18.0	20	35.0

ERENCE BETWEEN THE SURFACE AND 400 FT (T_0-T_{400})

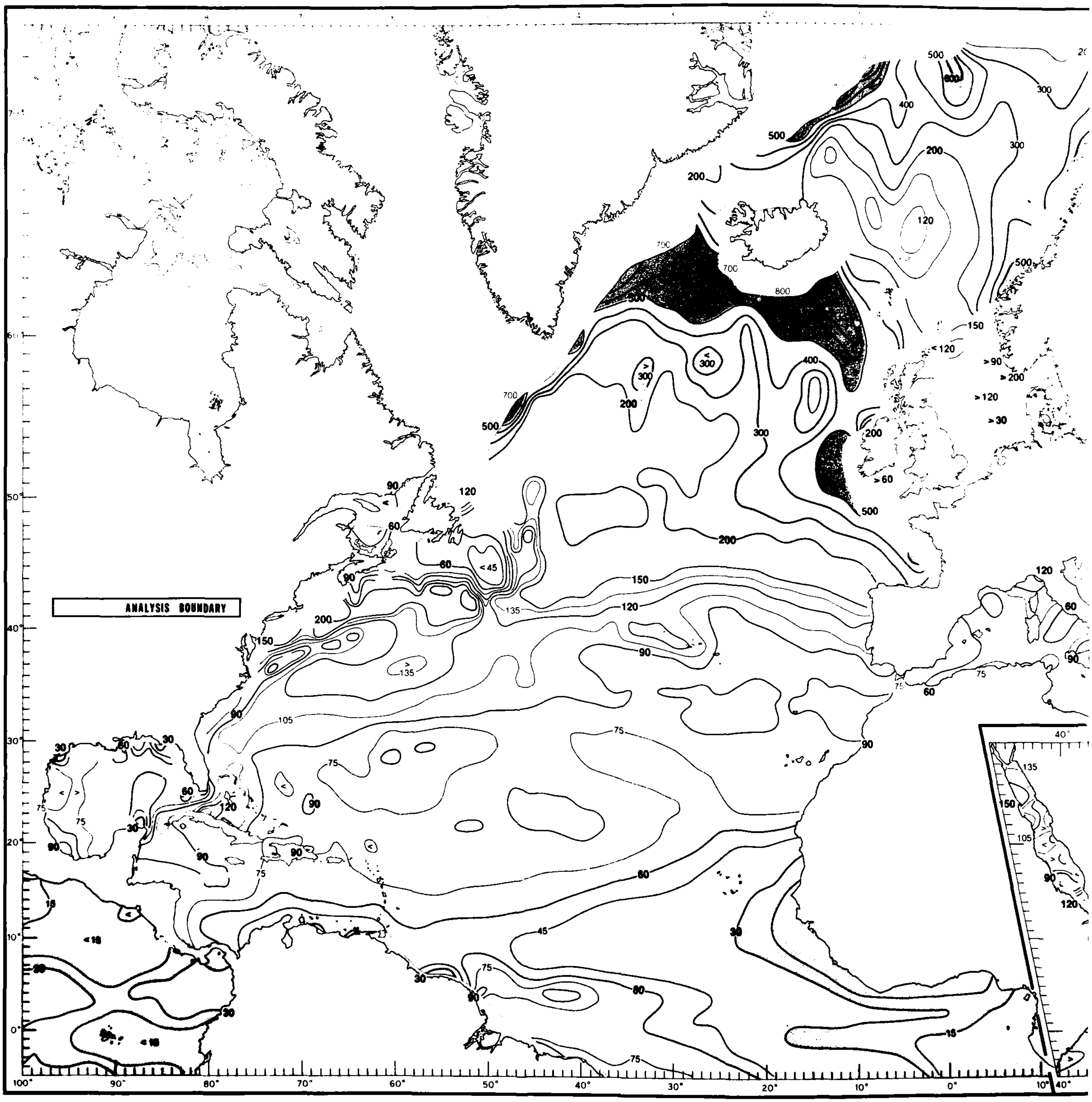
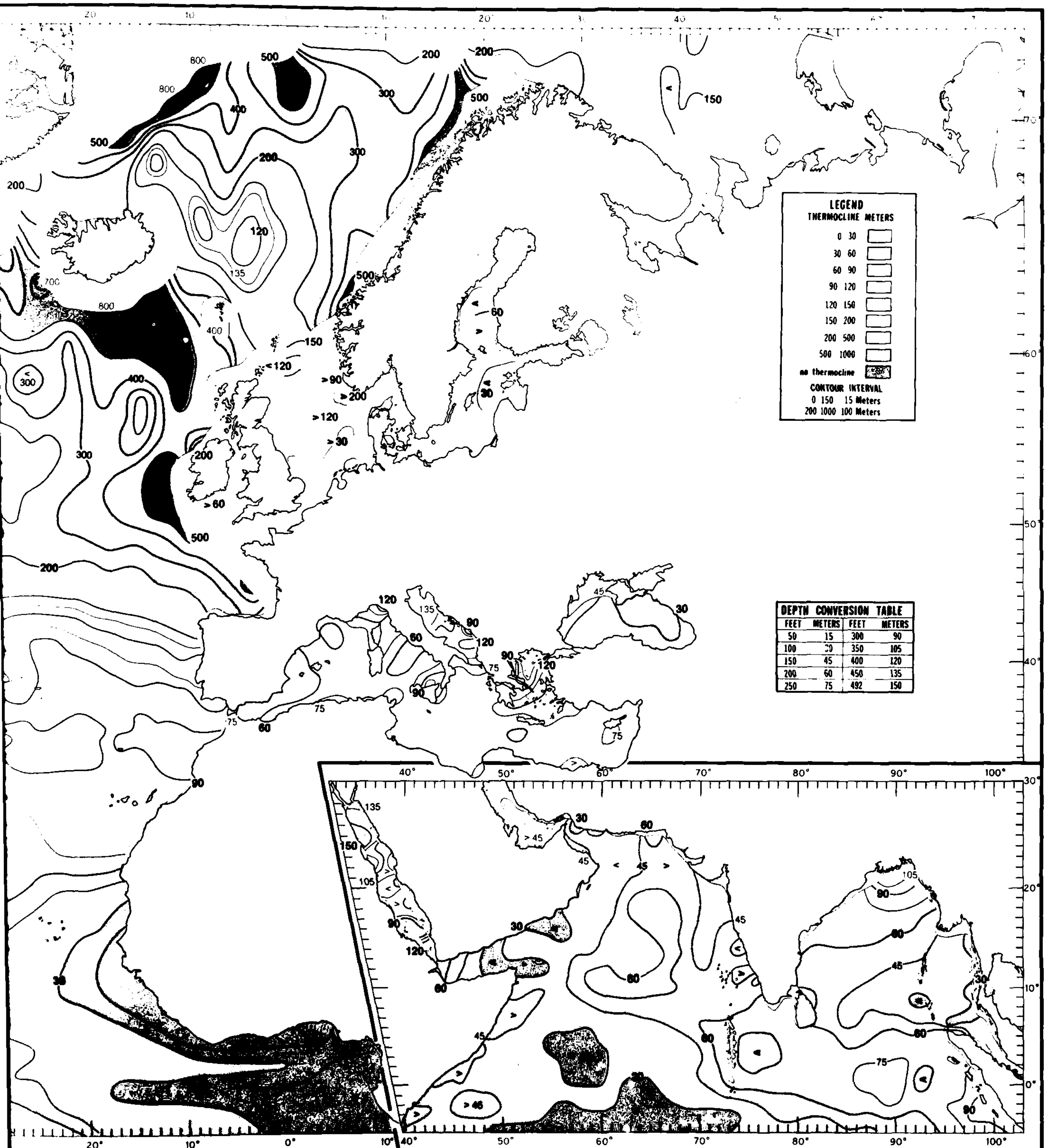


FIGURE 168. DECEMBER MEAN DEPTHS TO THE TOP OF THE THERMOCLINE



MBER MEAN DEPTHS TO THE TOP OF THE THERMOCLINE

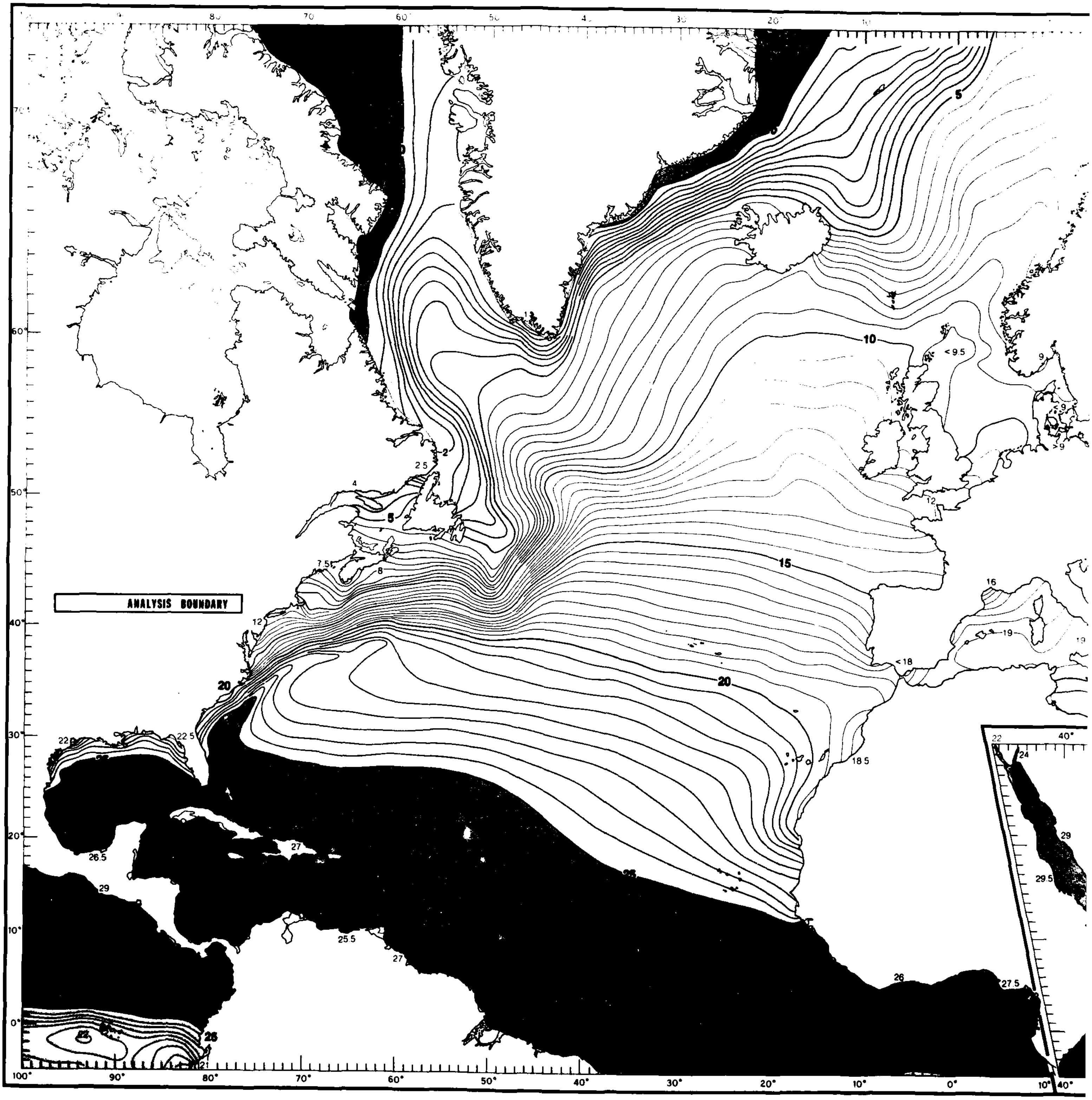
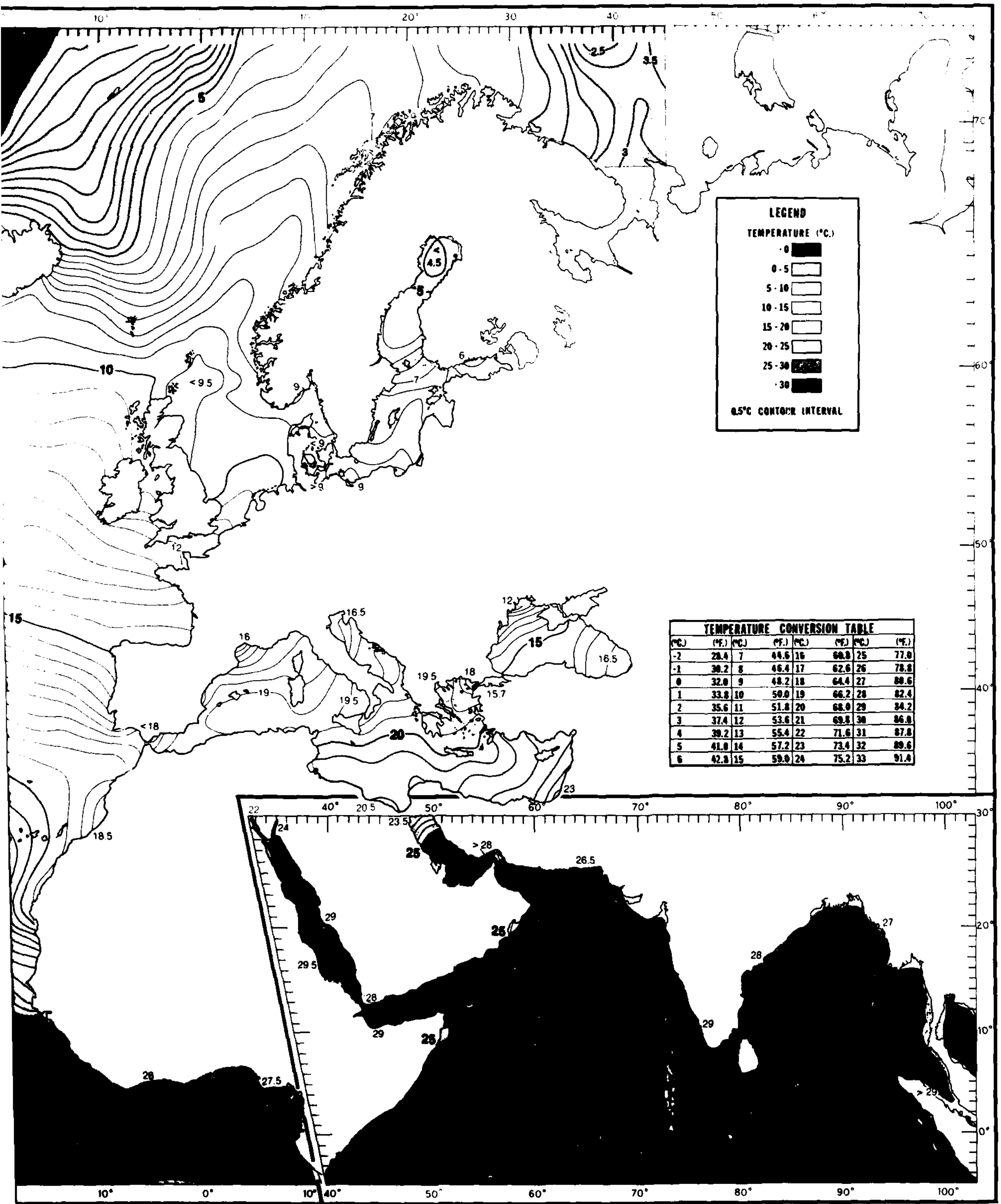


FIGURE 169. ANNUAL MEAN TEMPERATURES AT THE SURFACE



(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

EAN TEMPERATURES AT THE SURFACE

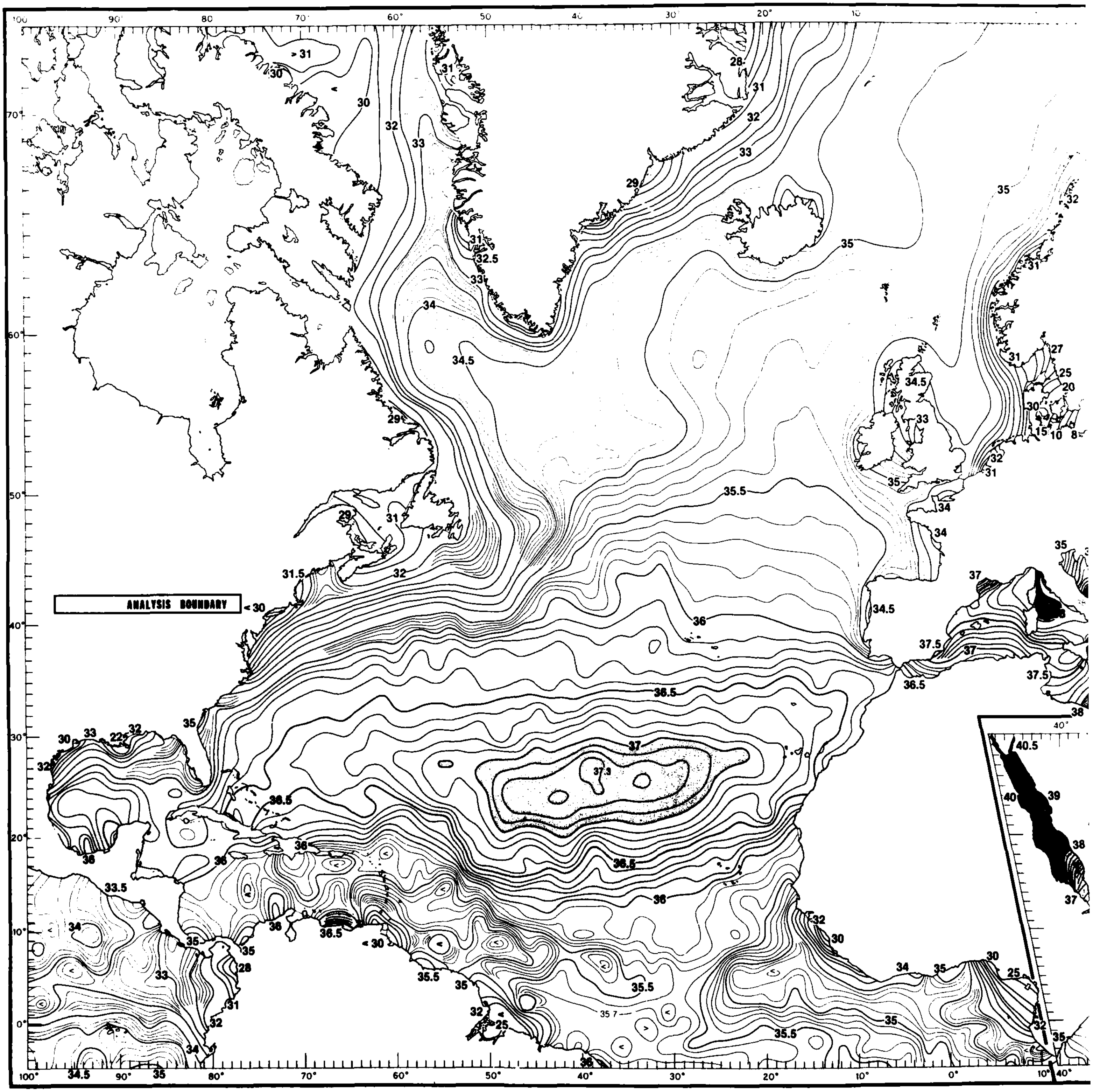
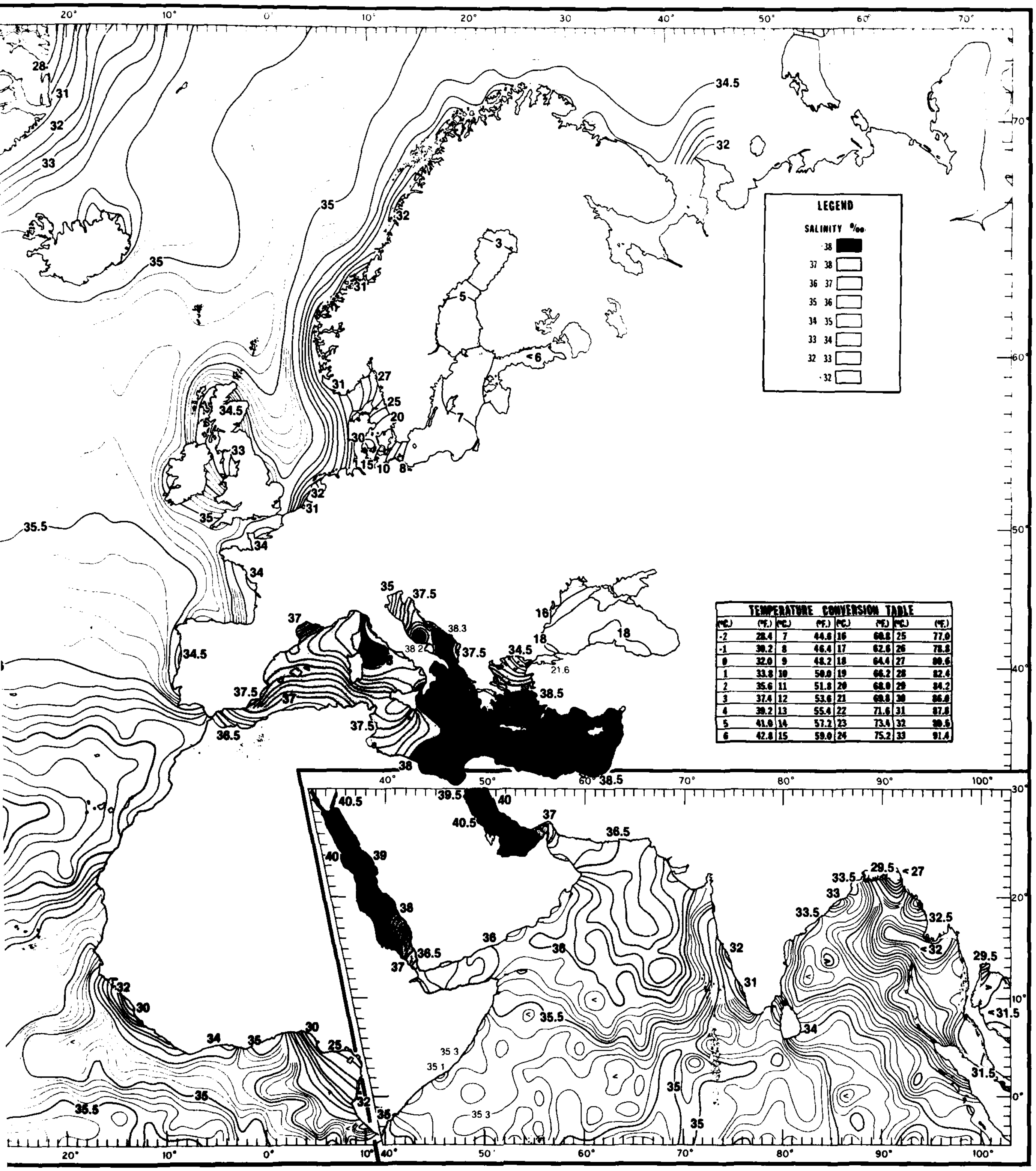


FIGURE 170. ANNUAL MEAN SALINITIES AT THE SURFACE



TEMPERATURE CONVERSION TABLE

(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

ANNUAL MEAN SALINITIES AT THE SURFACE

12

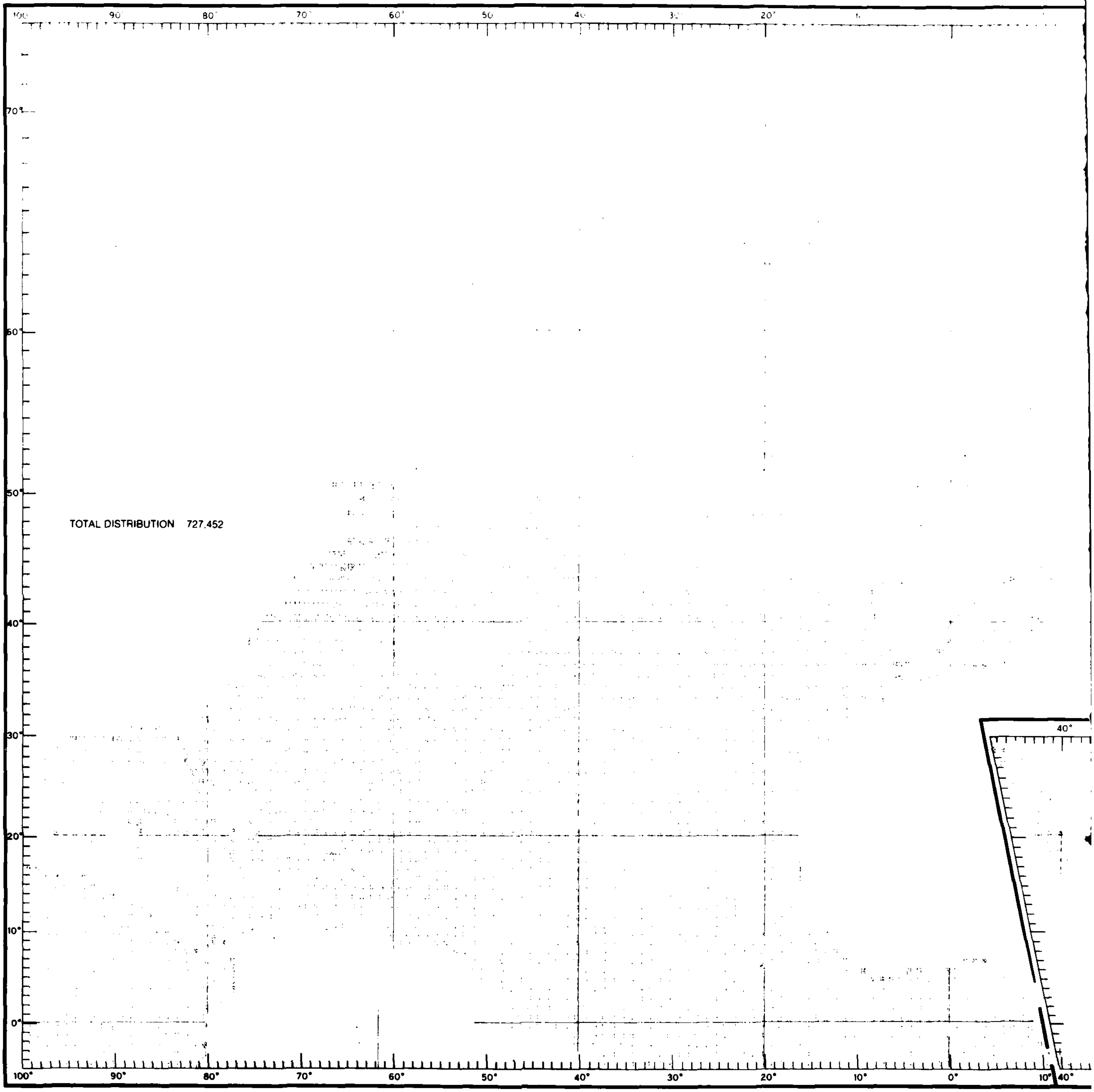
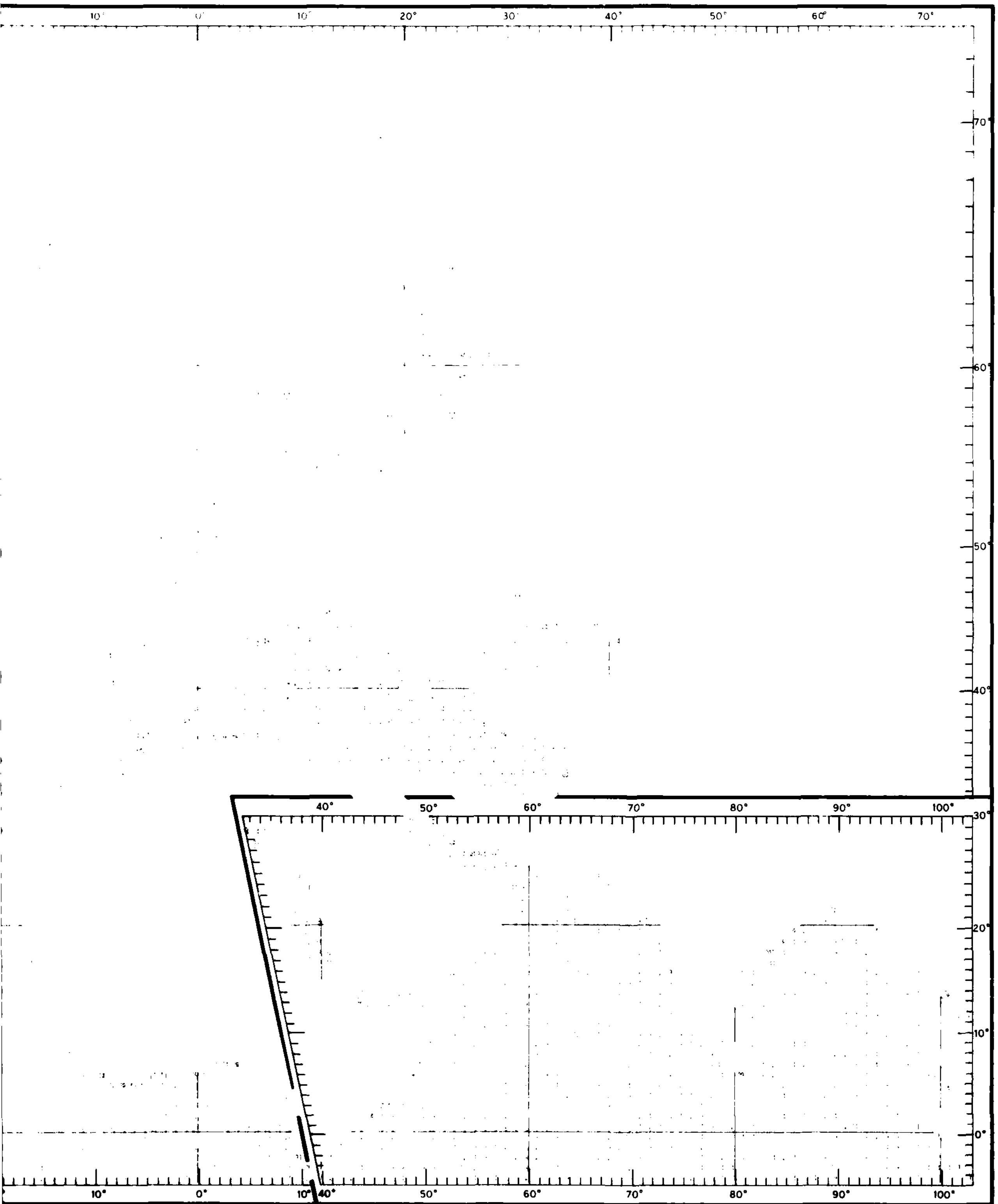


FIGURE 171. TOTAL DATA DISTRIBUTION OF TEMPERATURES AT THE SURFACE



IBUTION OF TEMPERATURES AT THE SURFACE

1 2

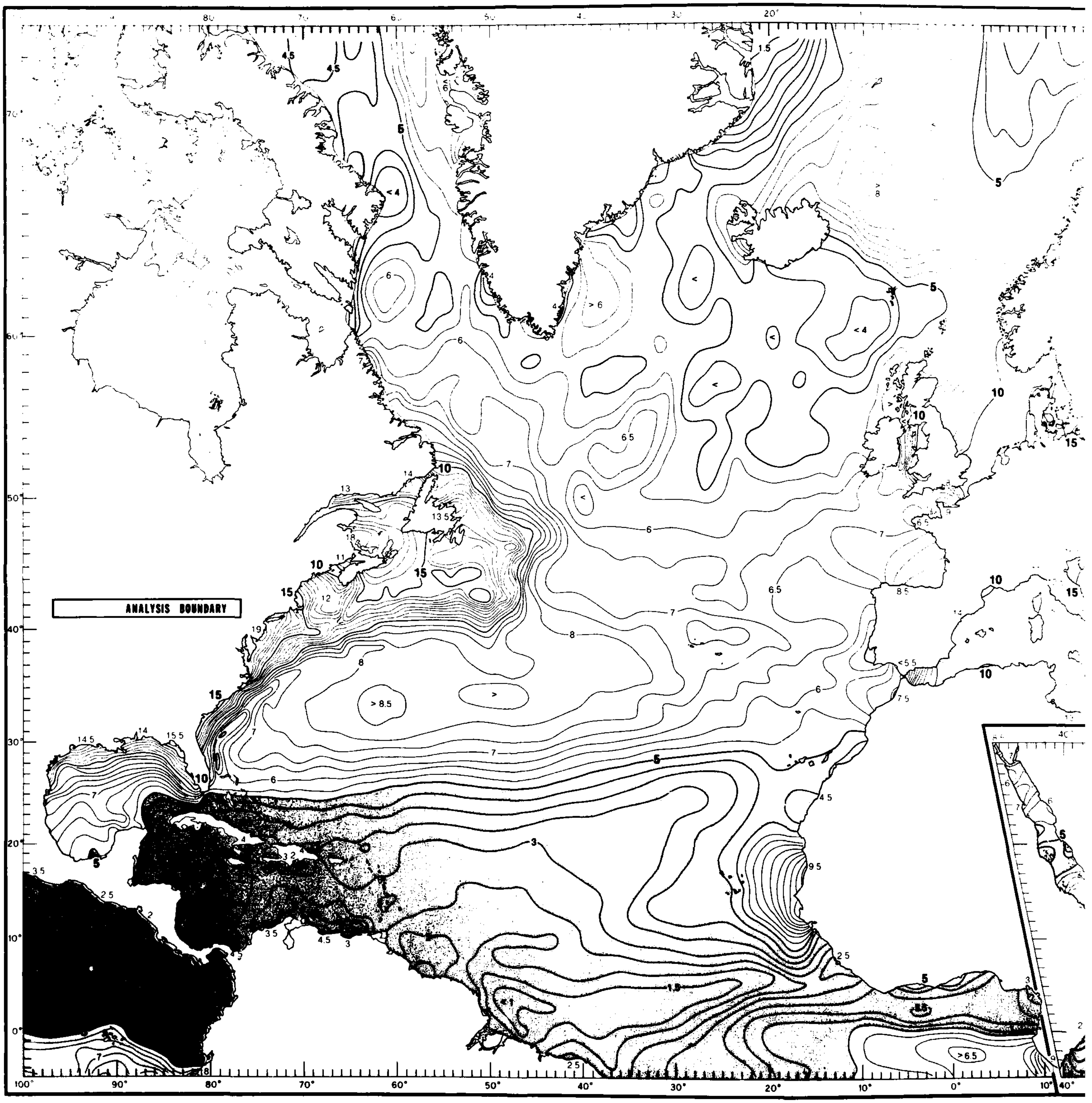
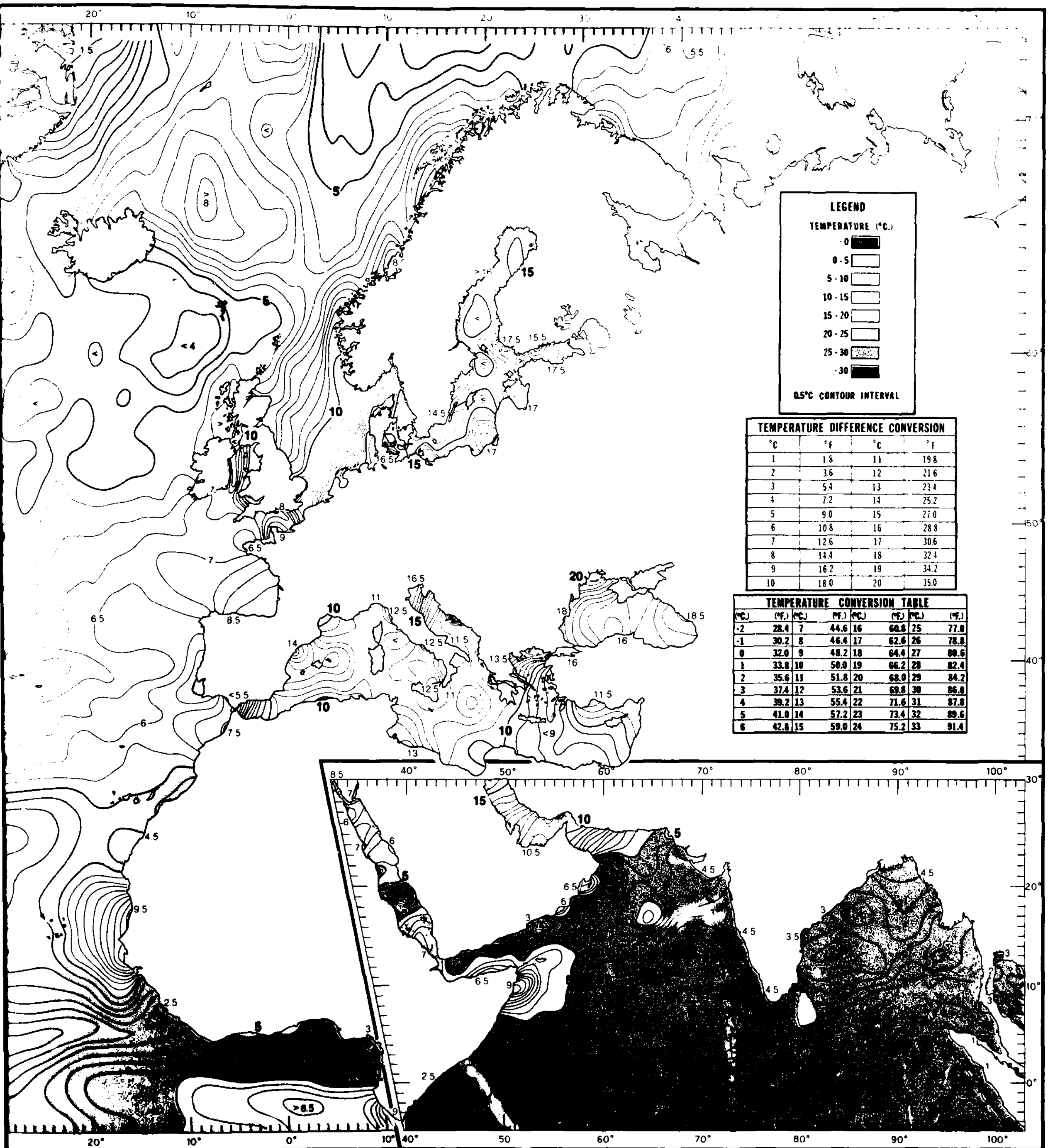


FIGURE 172. ANNUAL TEMPERATURE RANGE AT THE SURFACE



TEMPERATURE DIFFERENCE CONVERSION			
°C	°F	°C	°F
1	1.8	11	19.8
2	3.6	12	21.6
3	5.4	13	23.4
4	7.2	14	25.2
5	9.0	15	27.0
6	10.8	16	28.8
7	12.6	17	30.6
8	14.4	18	32.4
9	16.2	19	34.2
10	18.0	20	35.0

TEMPERATURE CONVERSION TABLE							
(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

. ANNUAL TEMPERATURE RANGE AT THE SURFACE

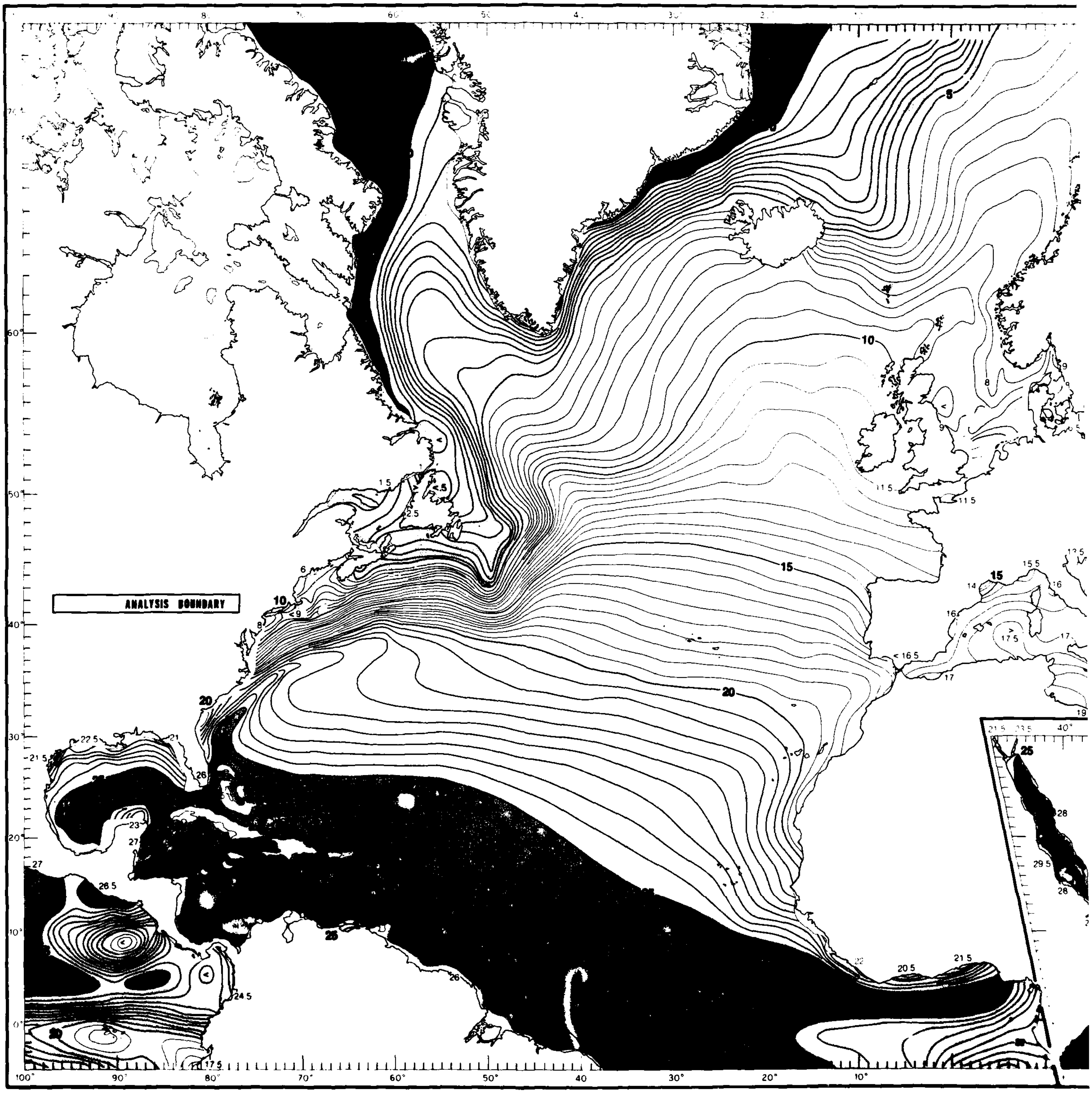
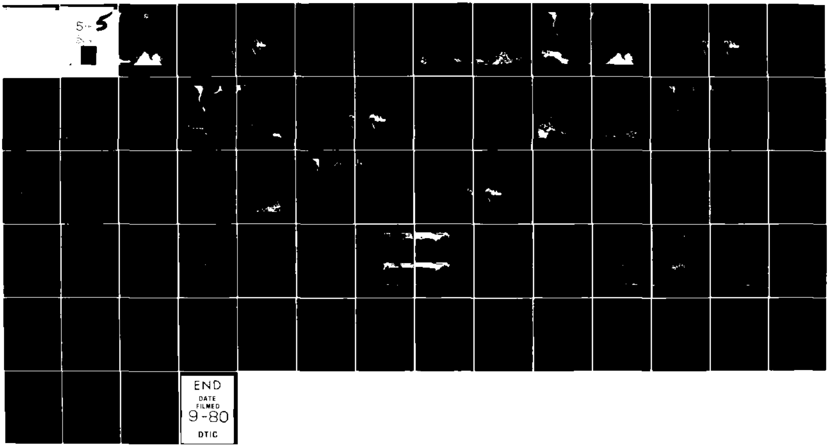
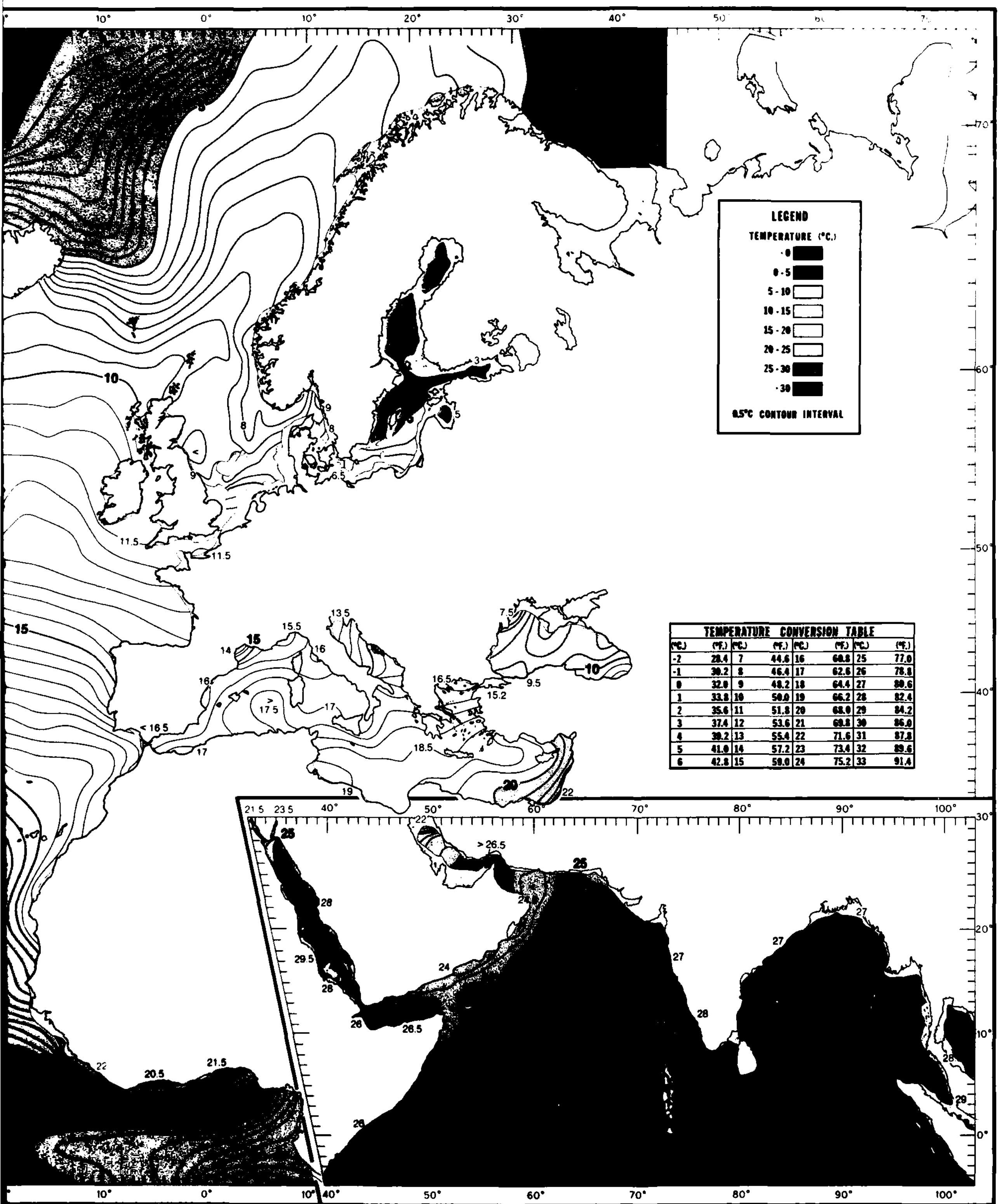


FIGURE 173. ANNUAL MEAN TEMPERATURES AT 100 F

AD-A087 571 NAVAL OCEANOGRAPHIC OFFICE NSTL STATION MS F/G 8/10
ATLAS OF NORTH ATLANTIC-INDIAN OCEAN MONTHLY MEAN TEMPERATURES --ETC(U)
1979 M K ROBINSON, R A BAUER, E H SCHROEDER
UNCLASSIFIED NOO-RP-18 NL





TEMPERATURE CONVERSION TABLE							
(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

EAN TEMPERATURES AT 100 FT (30 M)

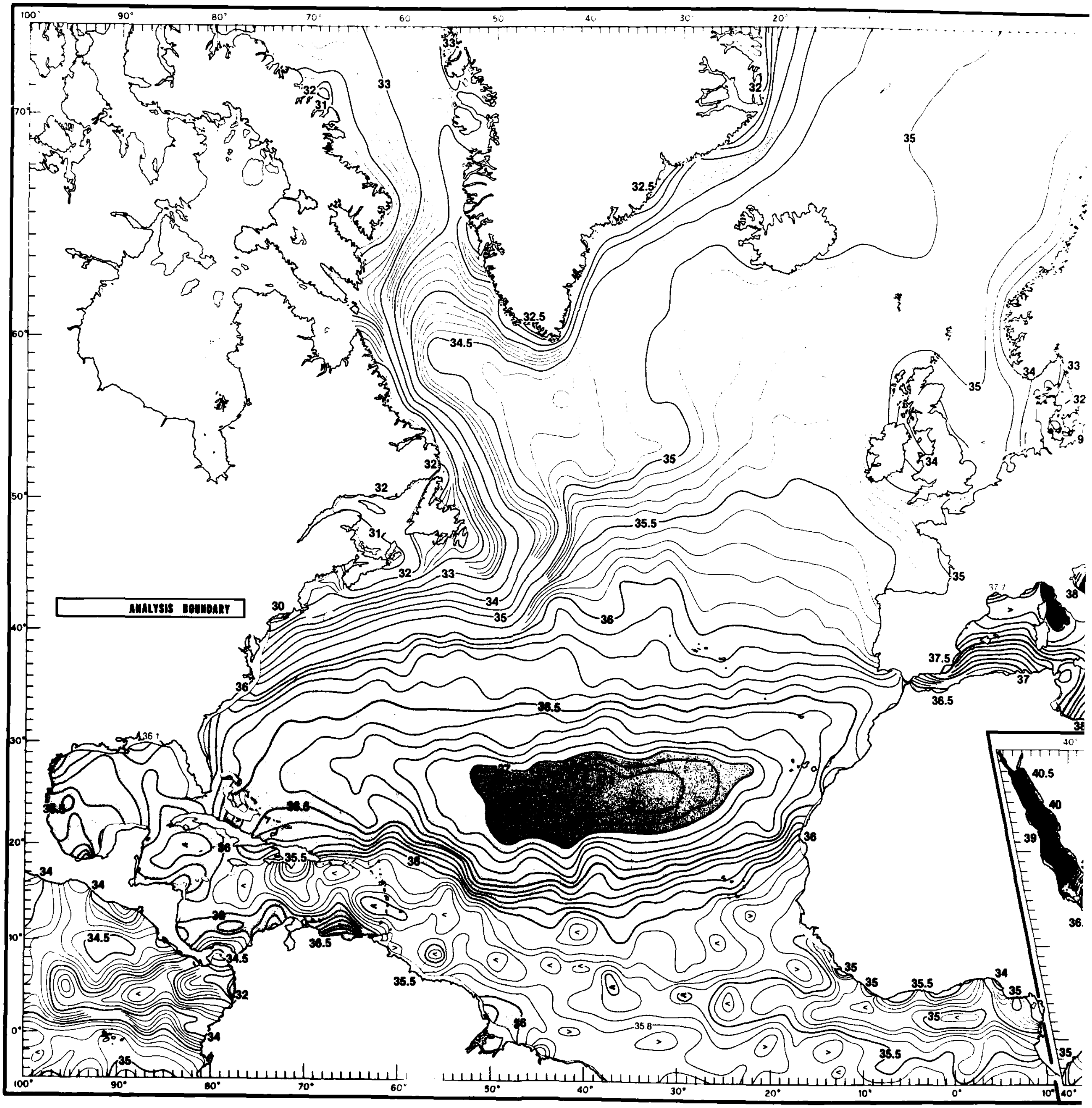
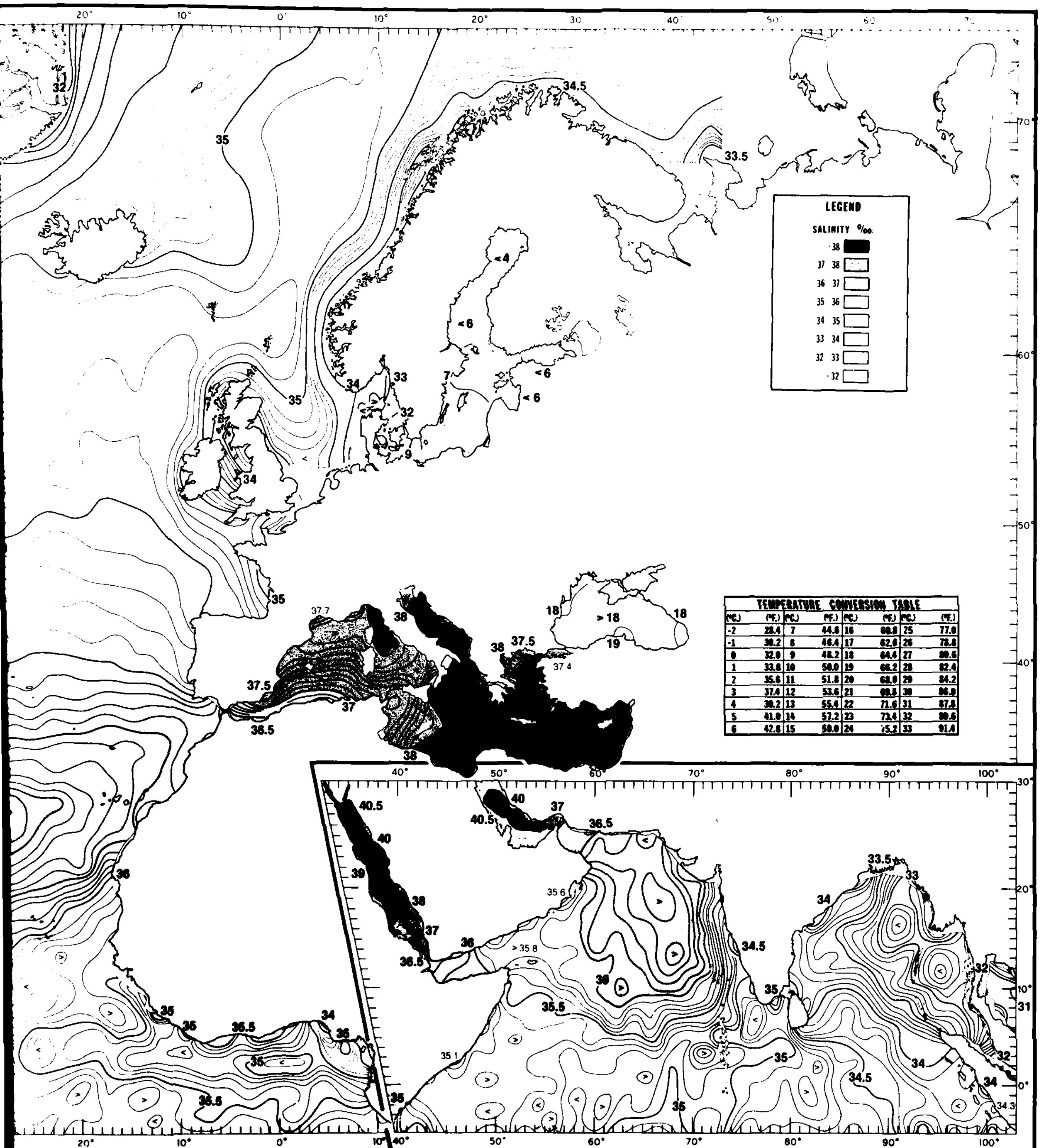


FIGURE 174. ANNUAL MEAN SALINITIES AT 100 Ft (30 M)

1



TEMPERATURE CONVERSION TABLE							
(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

ANNUAL MEAN SALINITIES AT 100 Ft (30 M)

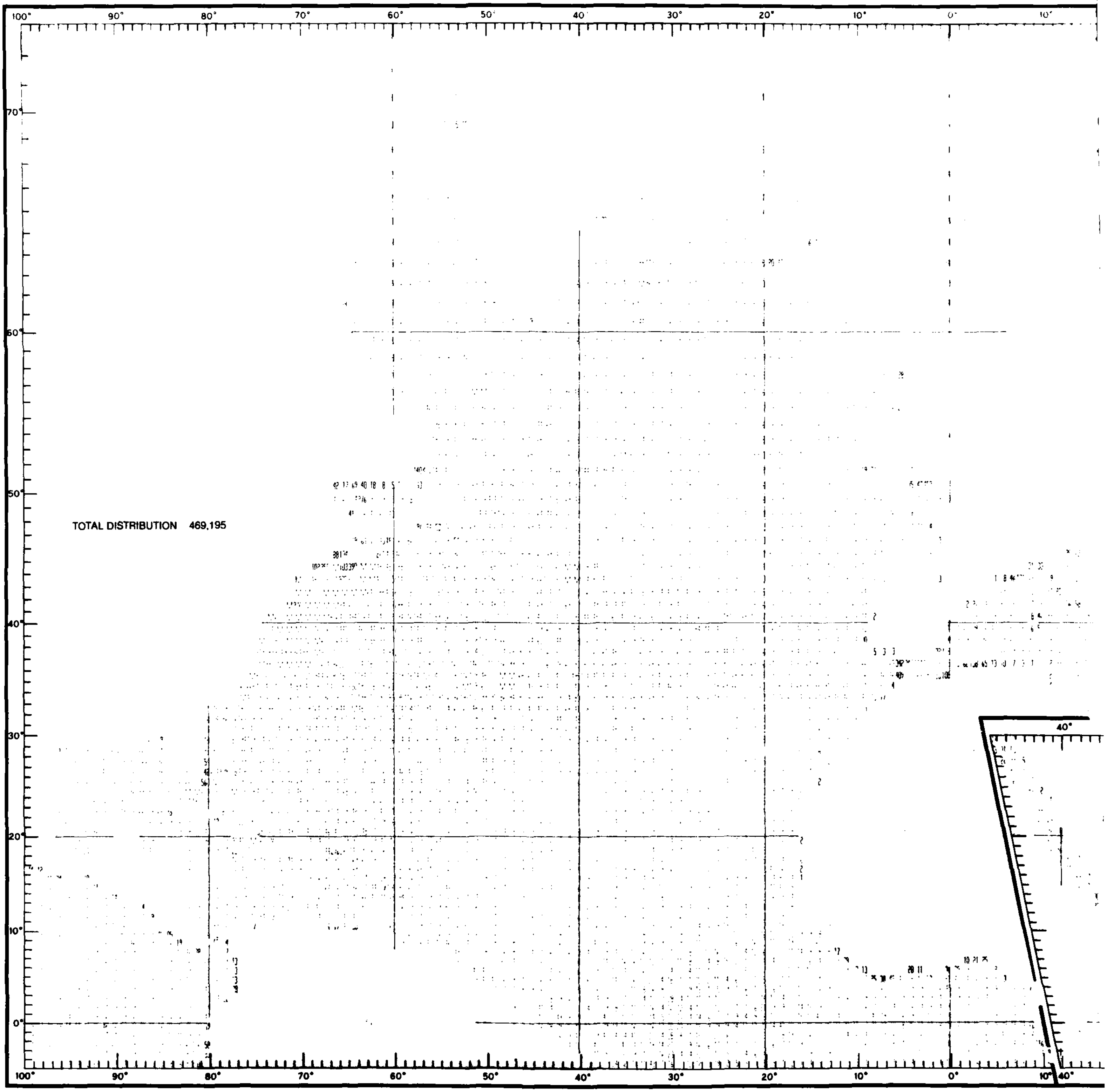
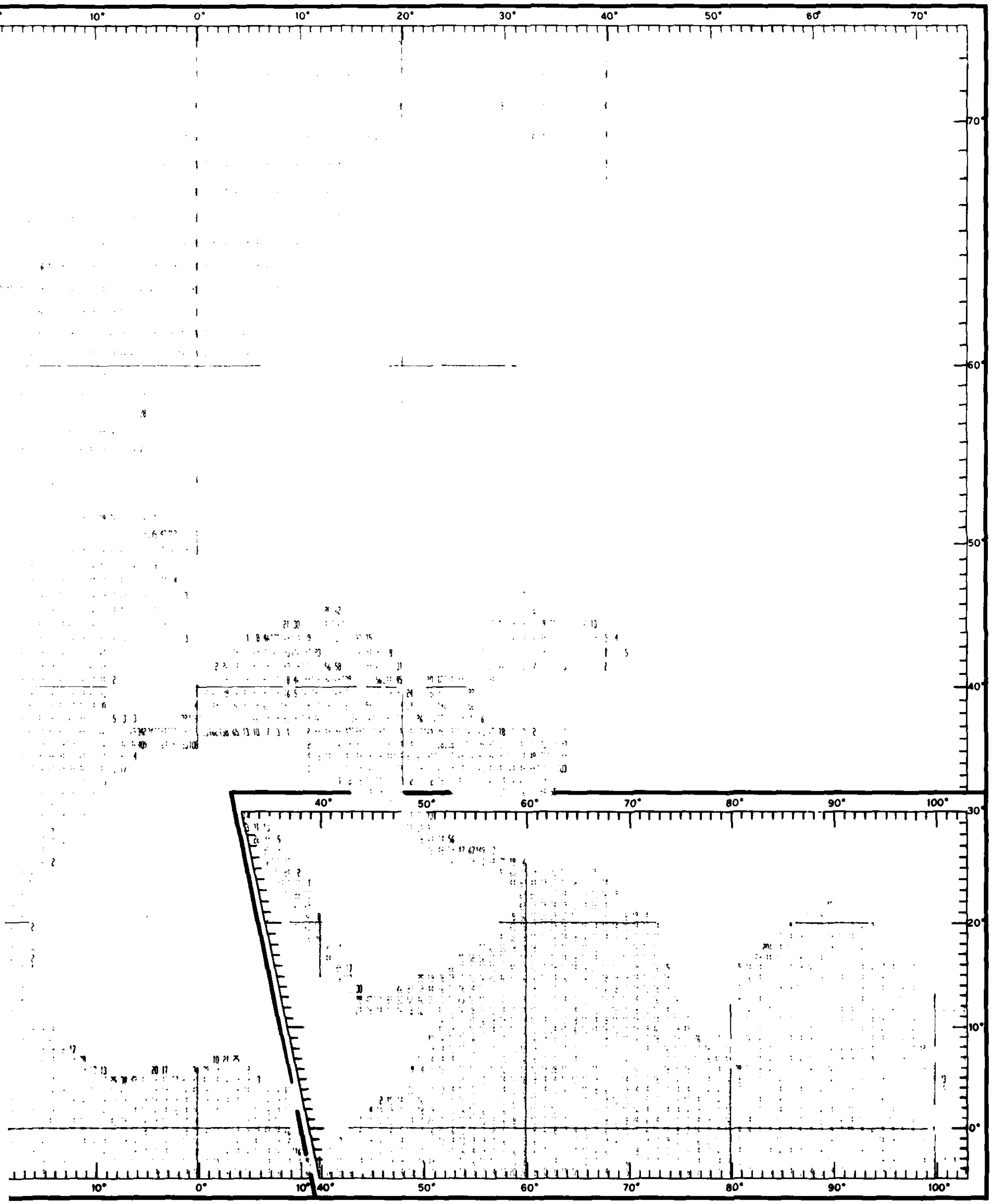


FIGURE 175. TOTAL DATA DISTRIBUTION OF TEMPERATURES AT 100 FT (30 M)



IBUTION OF TEMPERATURES AT 100 FT (30 M)

2

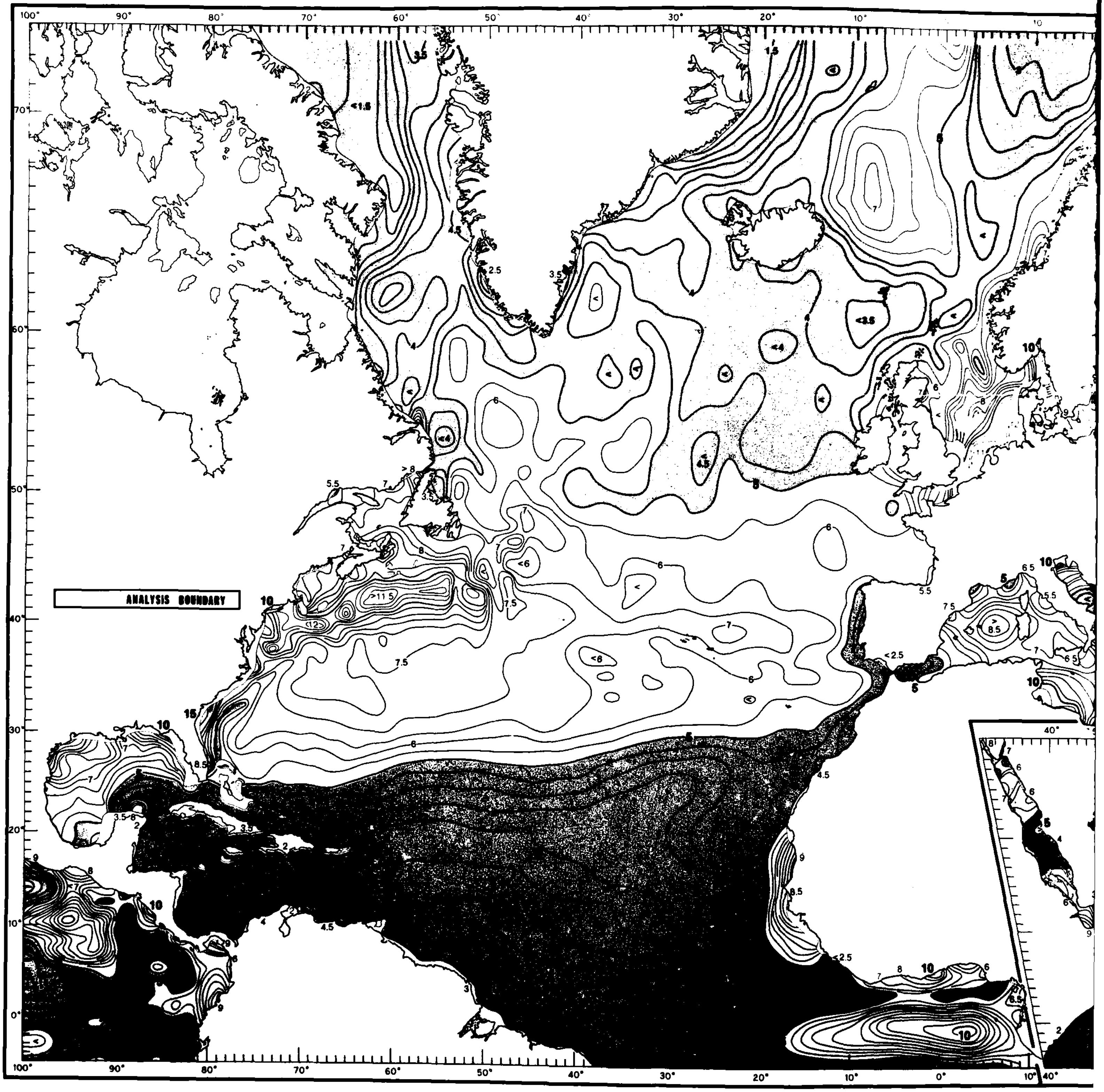
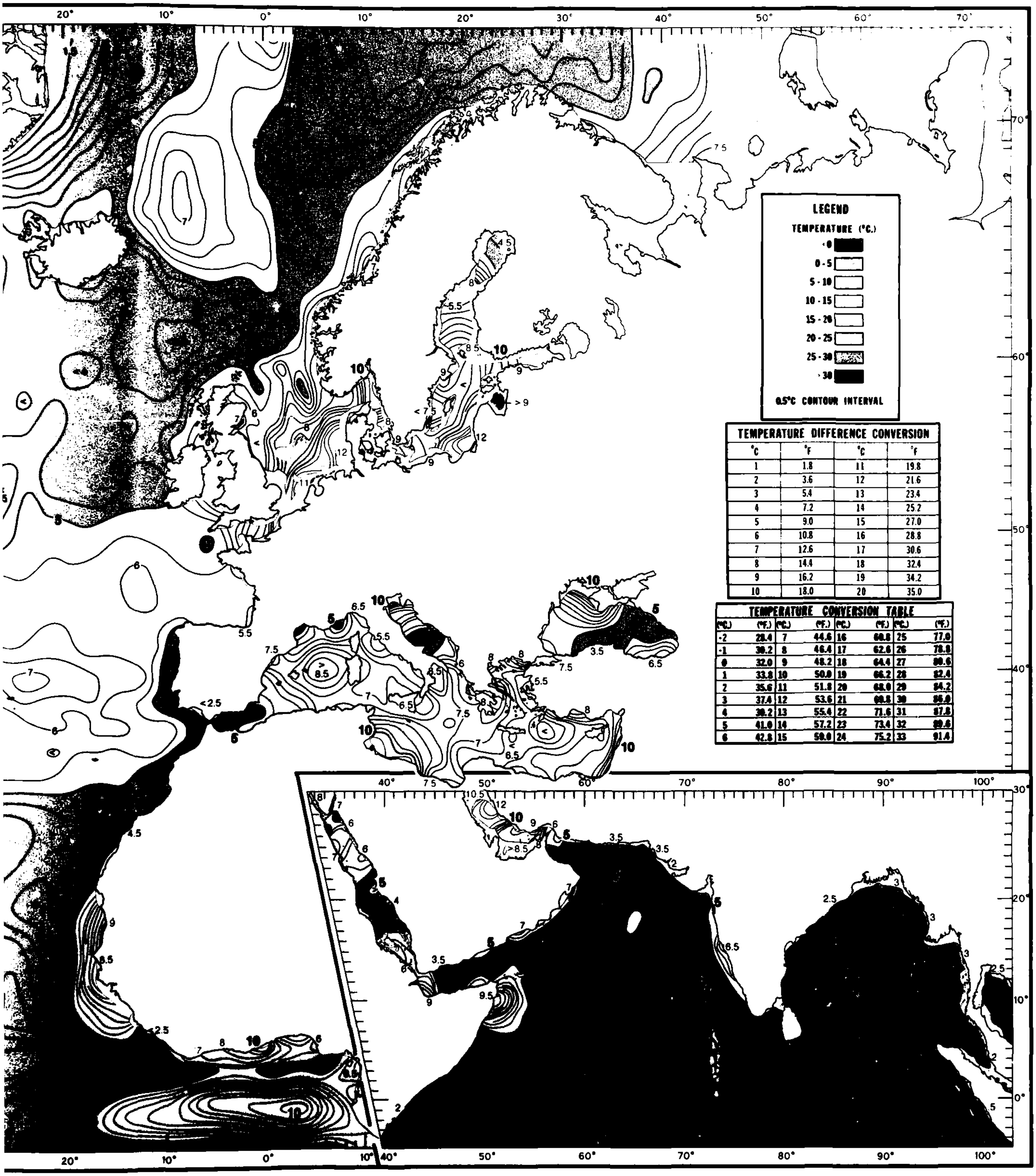


FIGURE 176. ANNUAL TEMPERATURE RANGE AT 100 FT (30 M)



TEMPERATURE DIFFERENCE CONVERSION			
°C	°F	°C	°F
1	1.8	11	19.8
2	3.6	12	21.6
3	5.4	13	23.4
4	7.2	14	25.2
5	9.0	15	27.0
6	10.8	16	28.8
7	12.6	17	30.6
8	14.4	18	32.4
9	16.2	19	34.2
10	18.0	20	35.0

TEMPERATURE CONVERSION TABLE							
(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

NNUAL TEMPERATURE RANGE AT 100 FT (30 M)

12

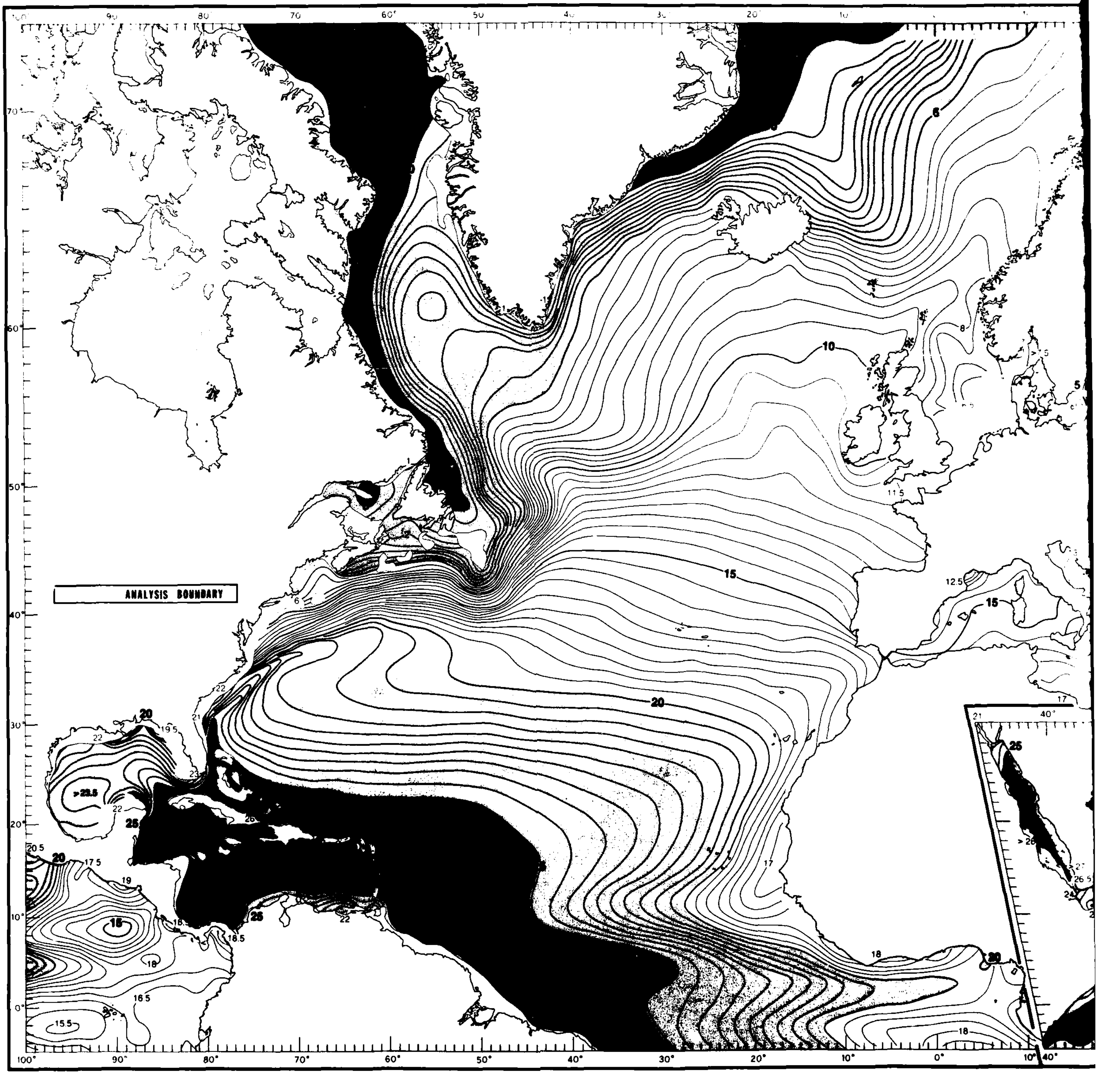
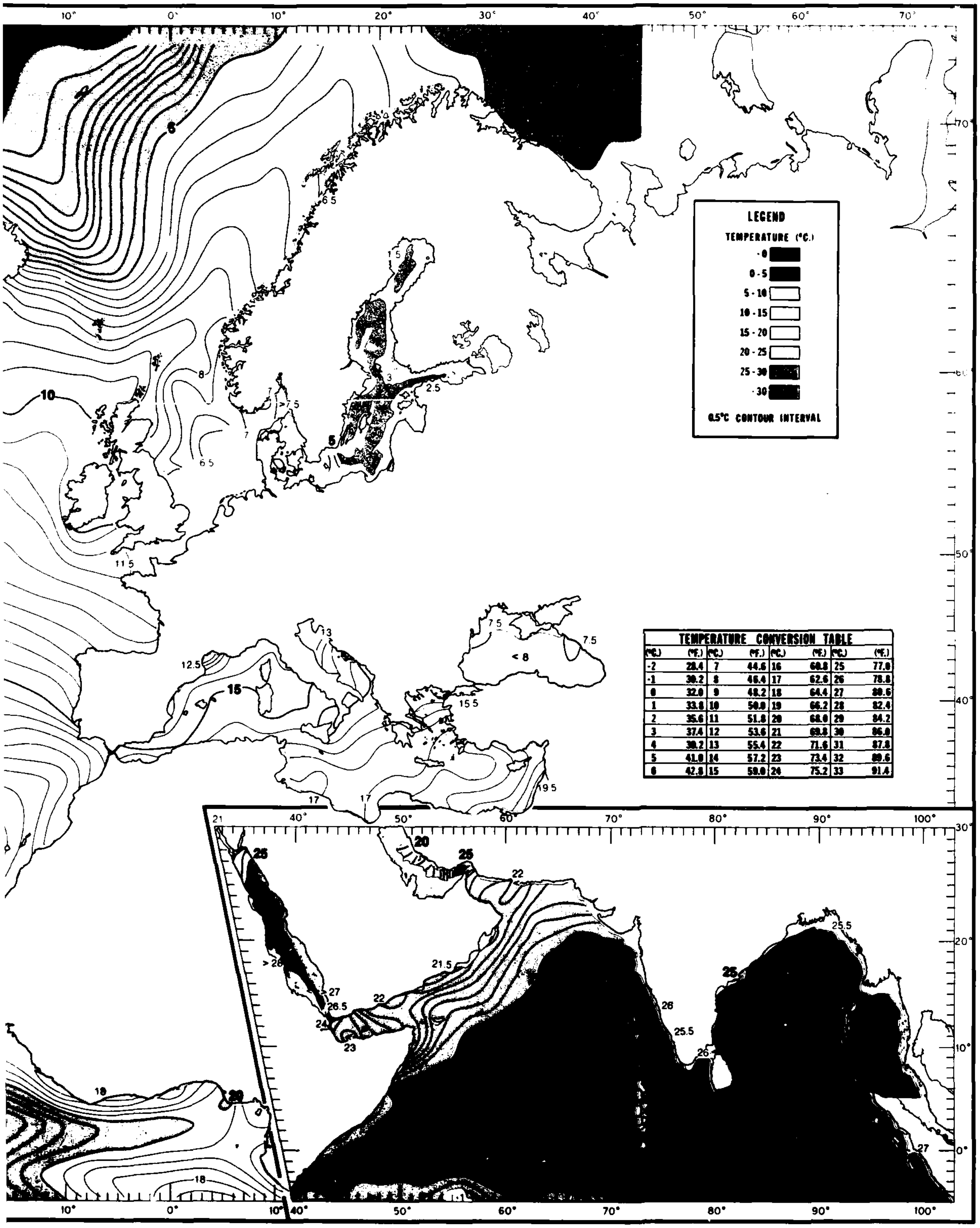


FIGURE 177. ANNUAL MEAN TEMPERATURES AT 200 FT (60 M)



TEMPERATURE CONVERSION TABLE							
(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

TEMPERATURES AT 200 FT (60 M)

1 2

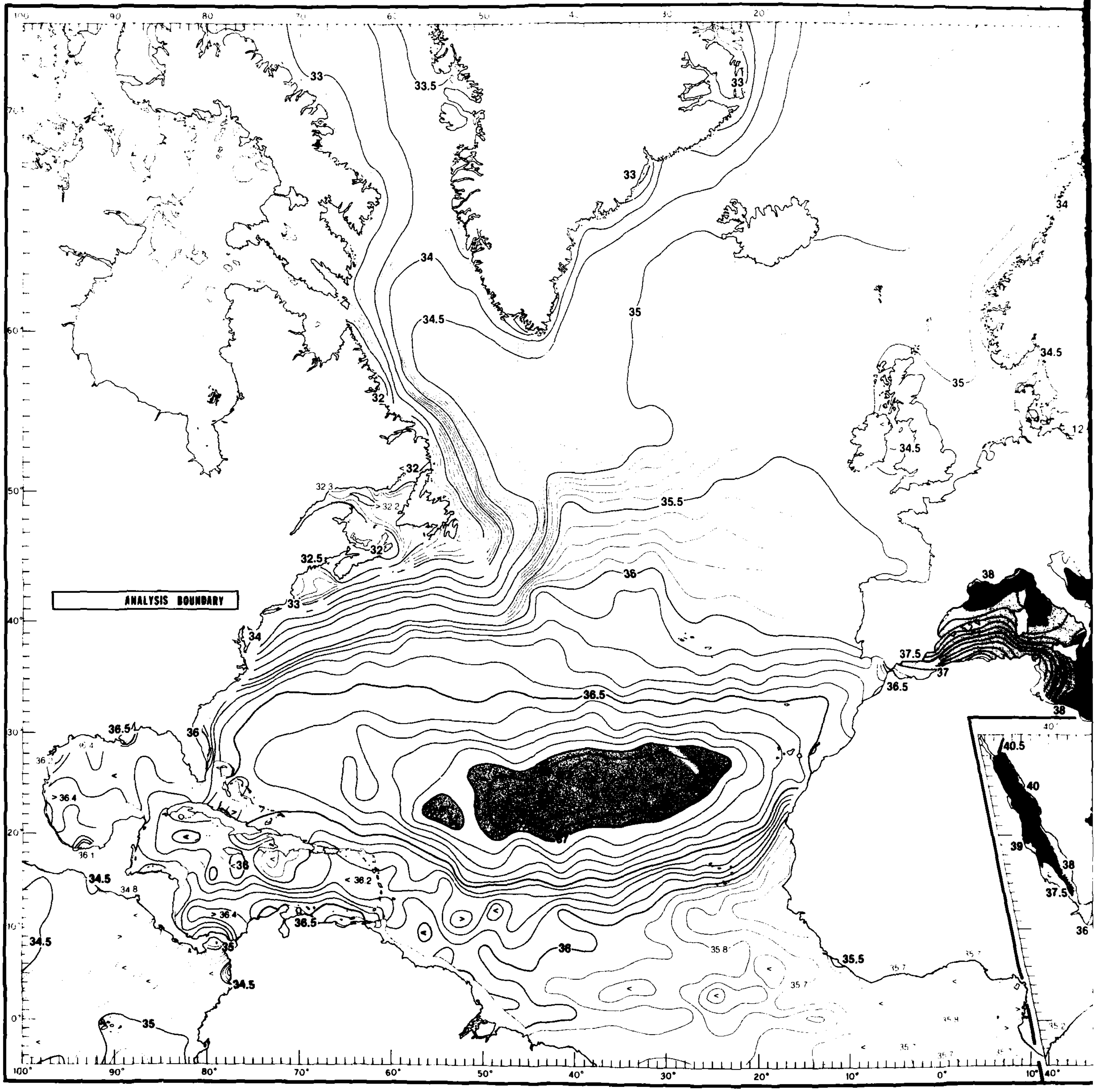
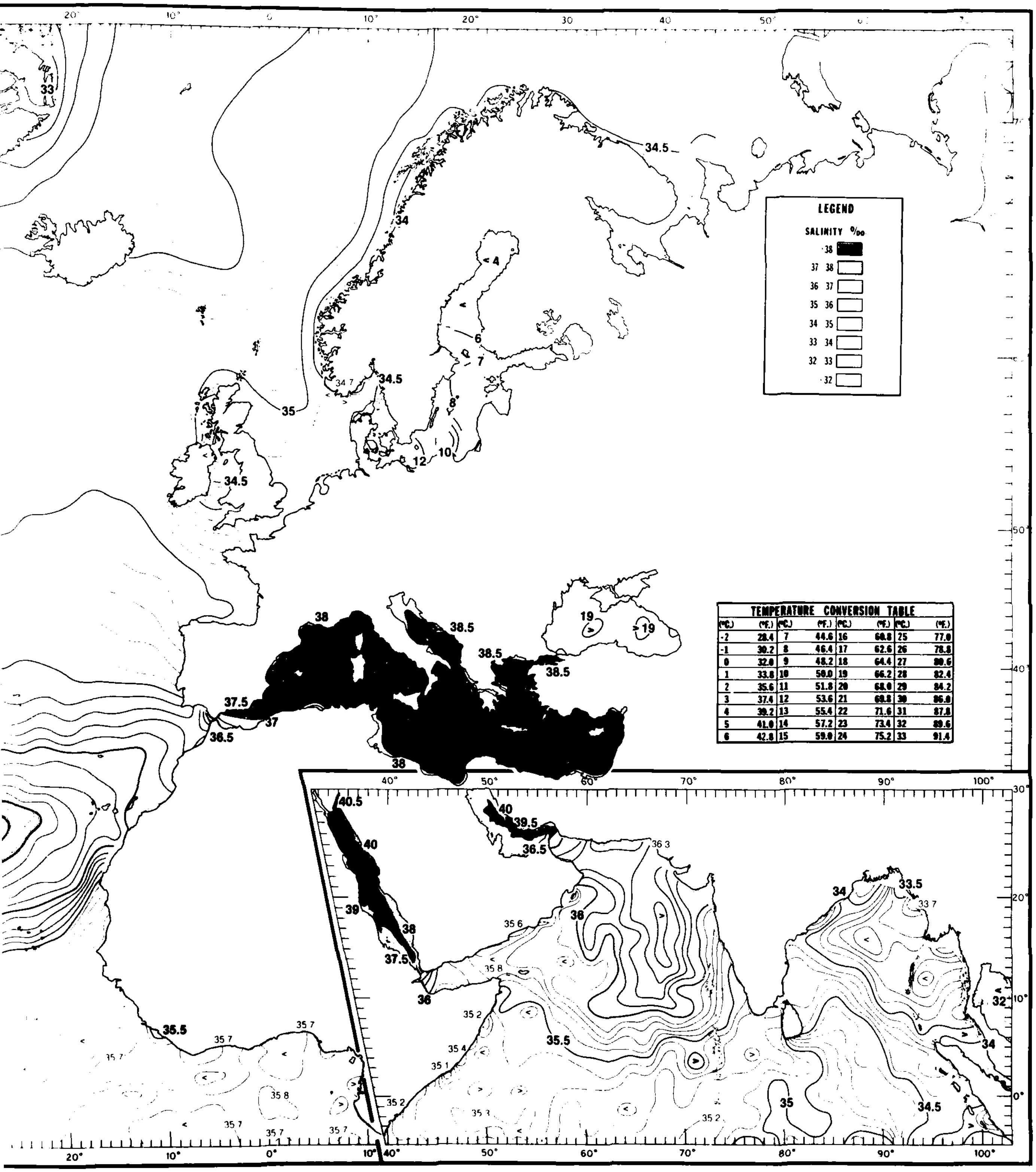


FIGURE 178. ANNUAL MEAN SALINITIES AT 200 FT (60 M)



TEMPERATURE CONVERSION TABLE							
(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

ANNUAL MEAN SALINITIES AT 200 FT (60 M)

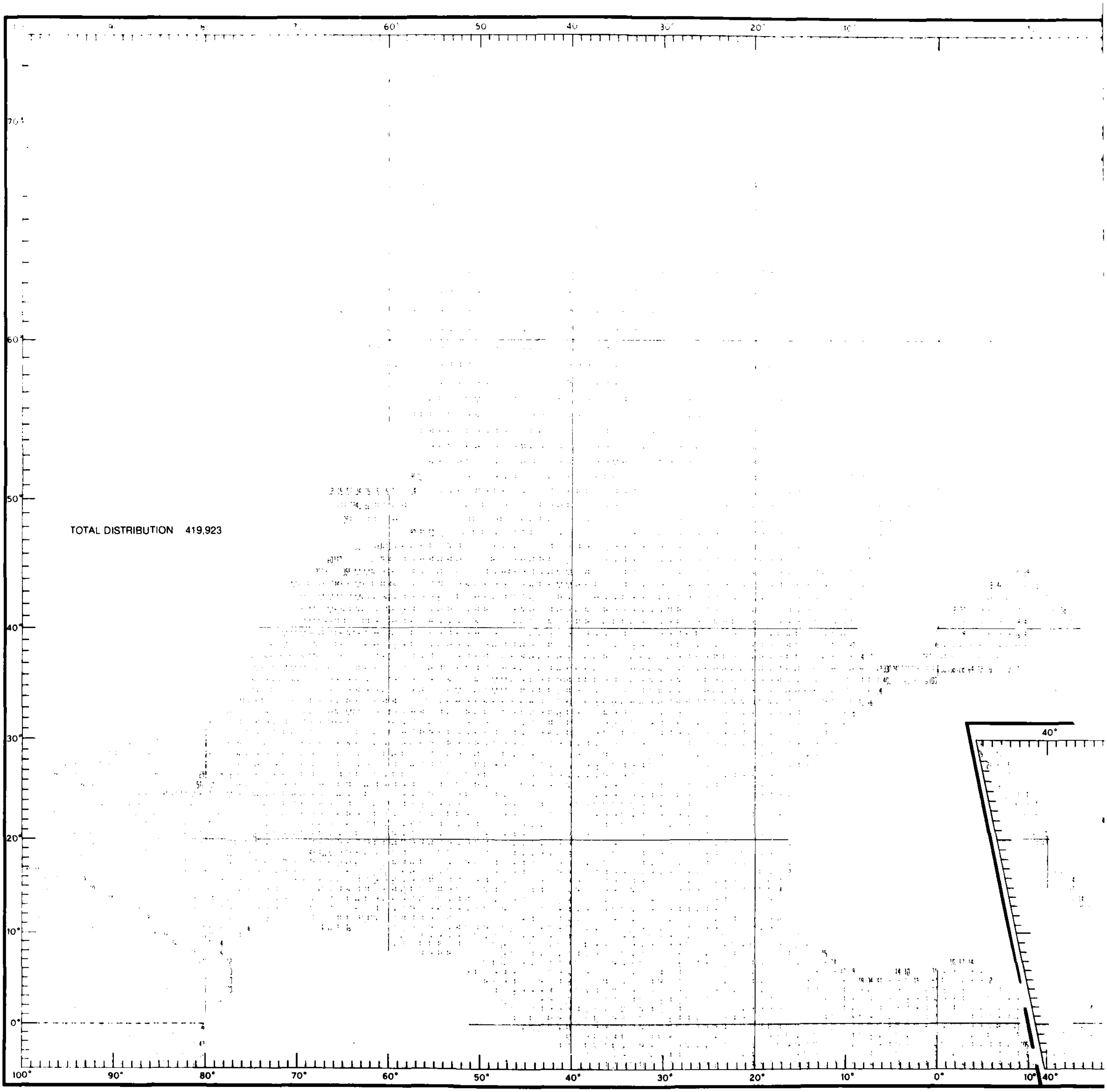
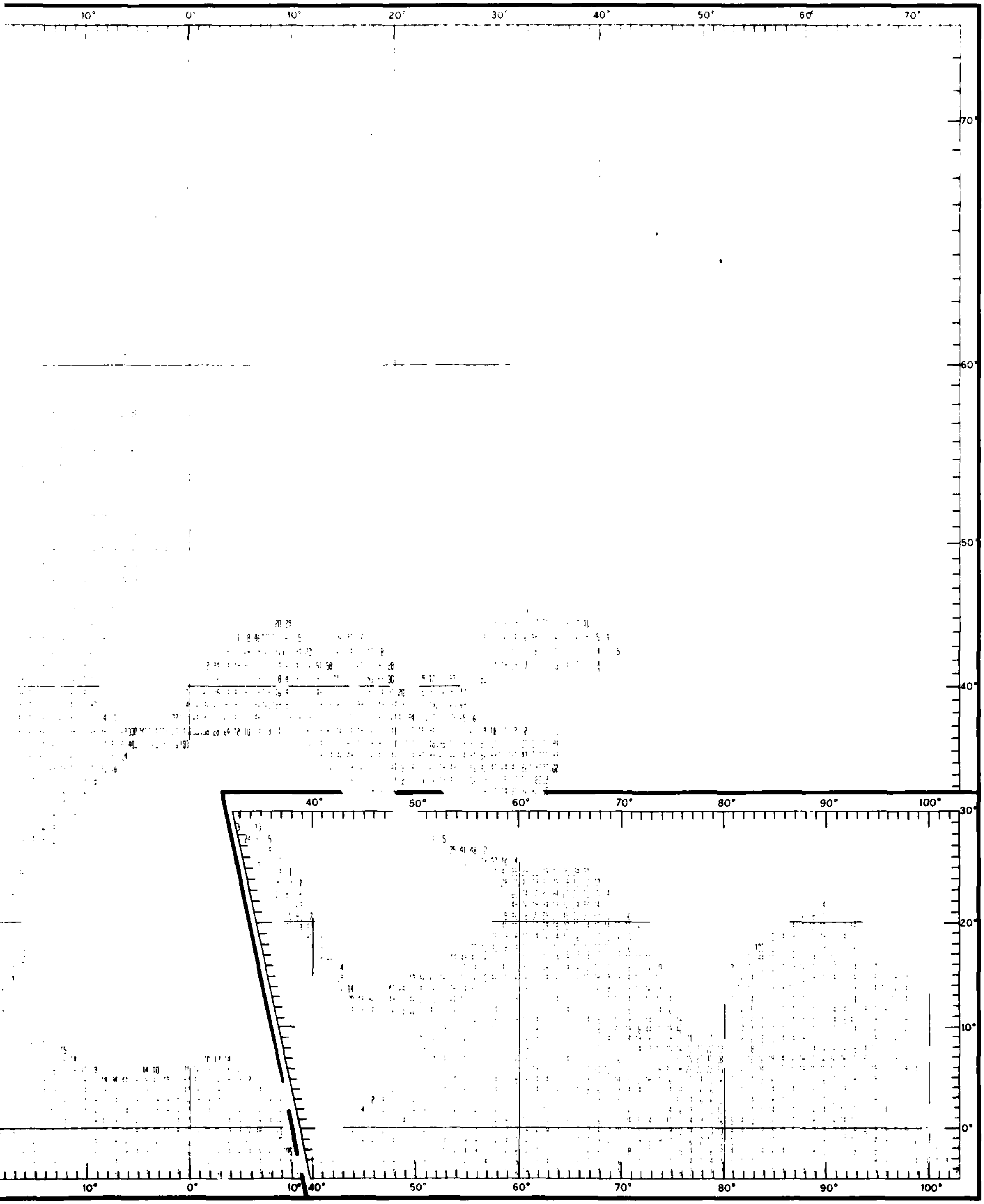


FIGURE 179. TOTAL DATA DISTRIBUTION OF TEMPERATURES AT 200 FT (60 M)



IBUTION OF TEMPERATURES AT 200 FT (60 M)

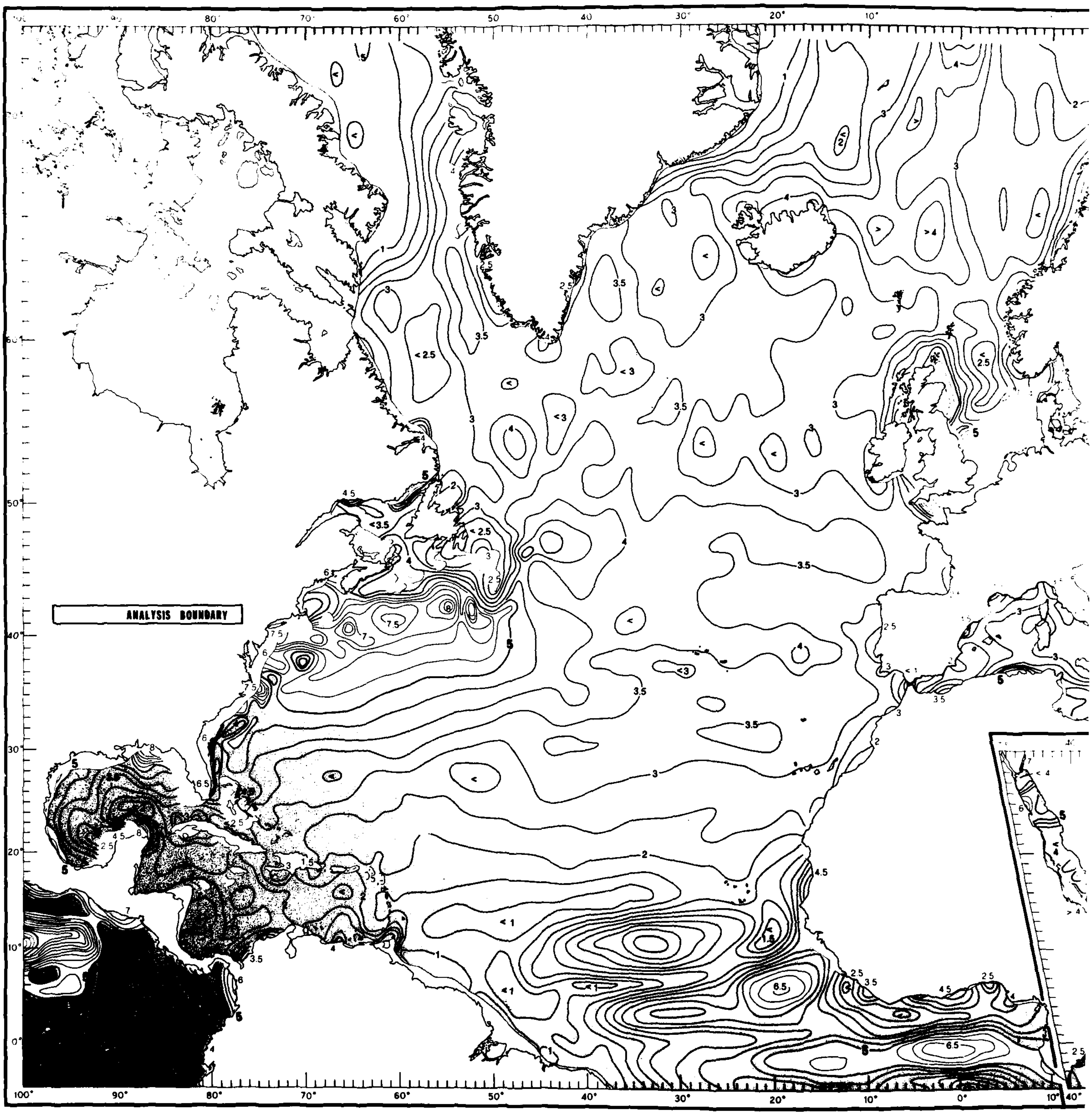
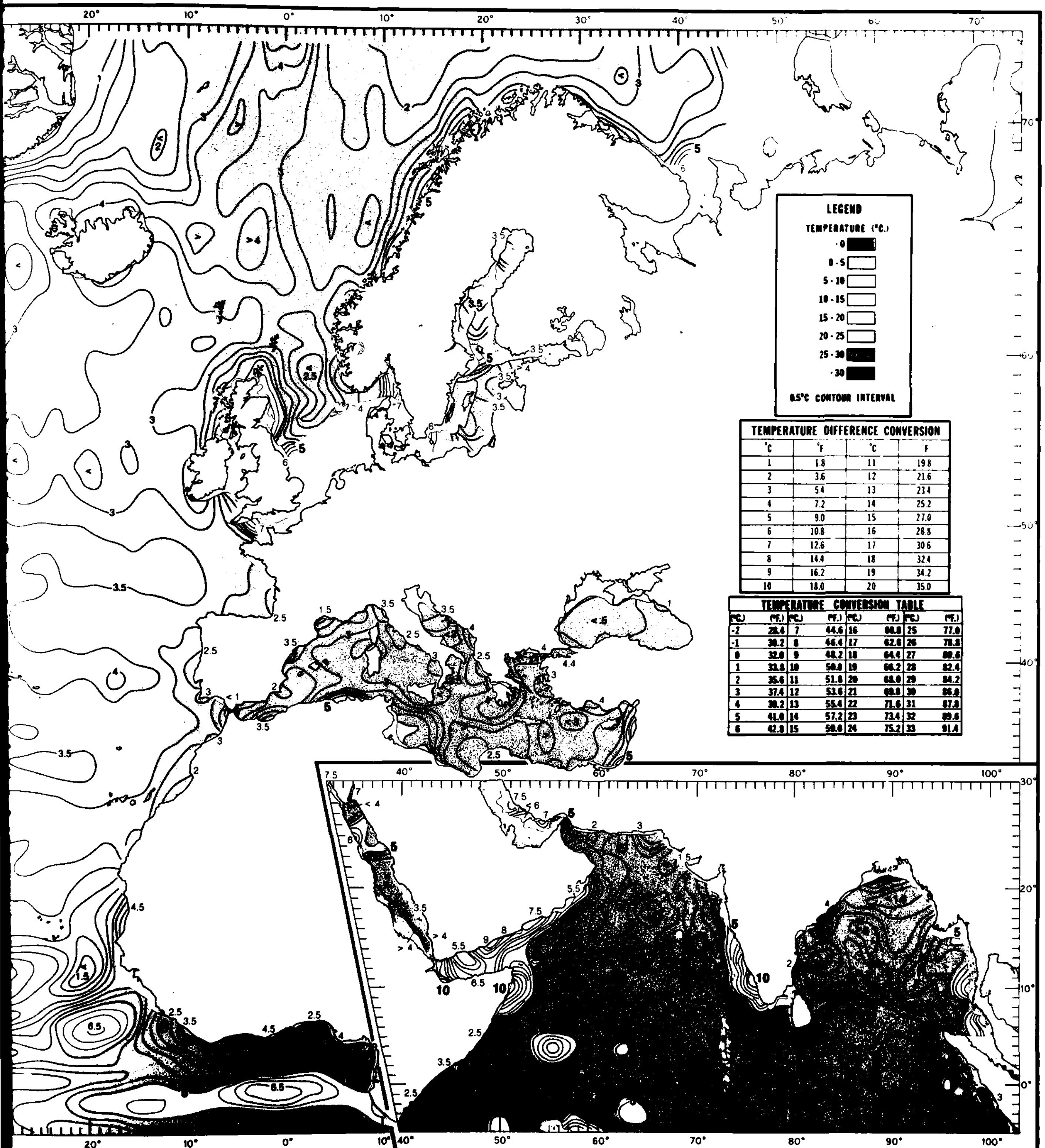


FIGURE 180. ANNUAL TEMPERATURE RANGE AT 200 FT (60 M)



TEMPERATURE DIFFERENCE CONVERSION			
°C	°F	°C	°F
1	1.8	11	19.8
2	3.6	12	21.6
3	5.4	13	23.4
4	7.2	14	25.2
5	9.0	15	27.0
6	10.8	16	28.8
7	12.6	17	30.6
8	14.4	18	32.4
9	16.2	19	34.2
10	18.0	20	35.0

TEMPERATURE CONVERSION TABLE							
(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

ANNUAL TEMPERATURE RANGE AT 200 FT (60 M)

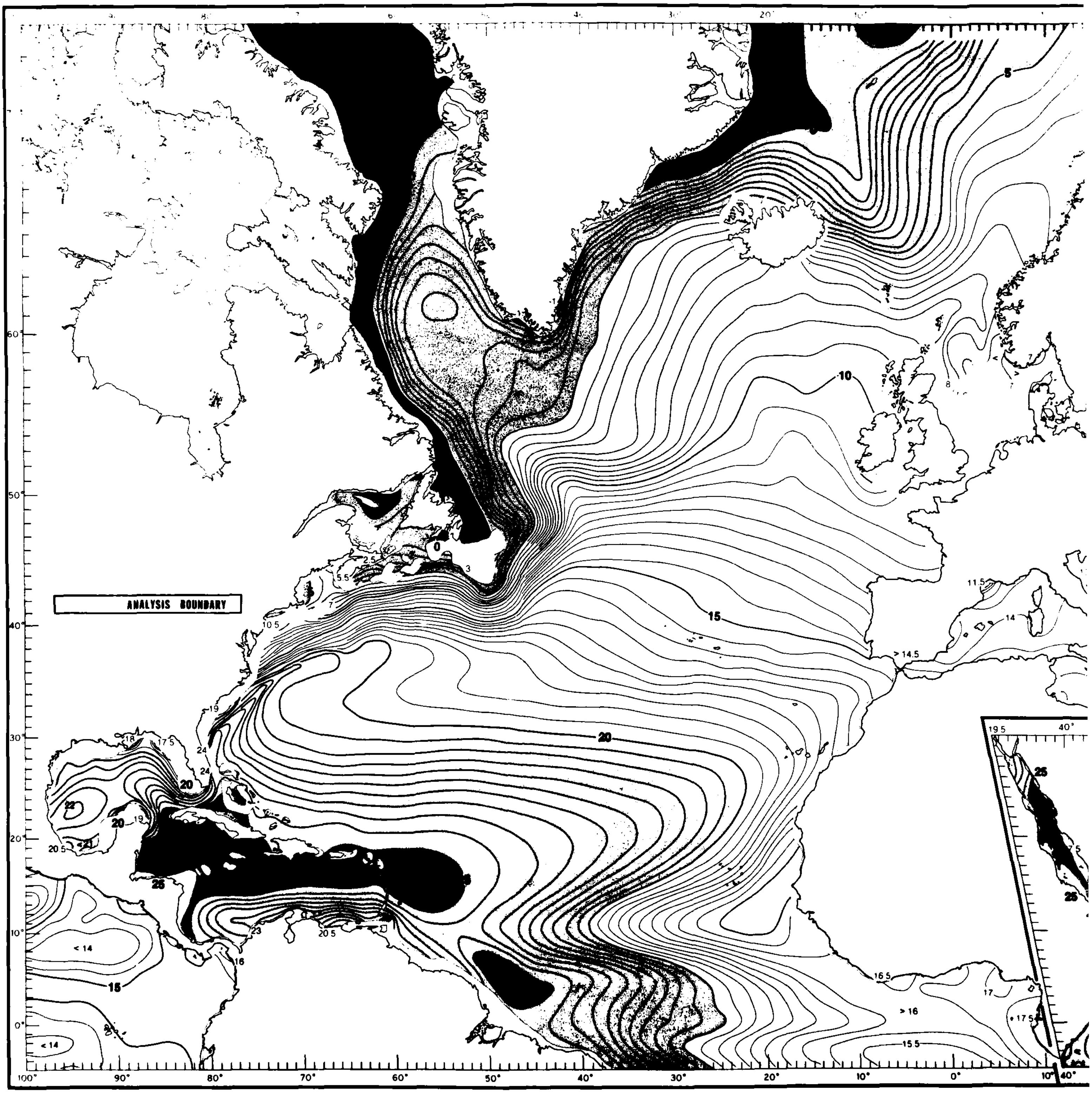
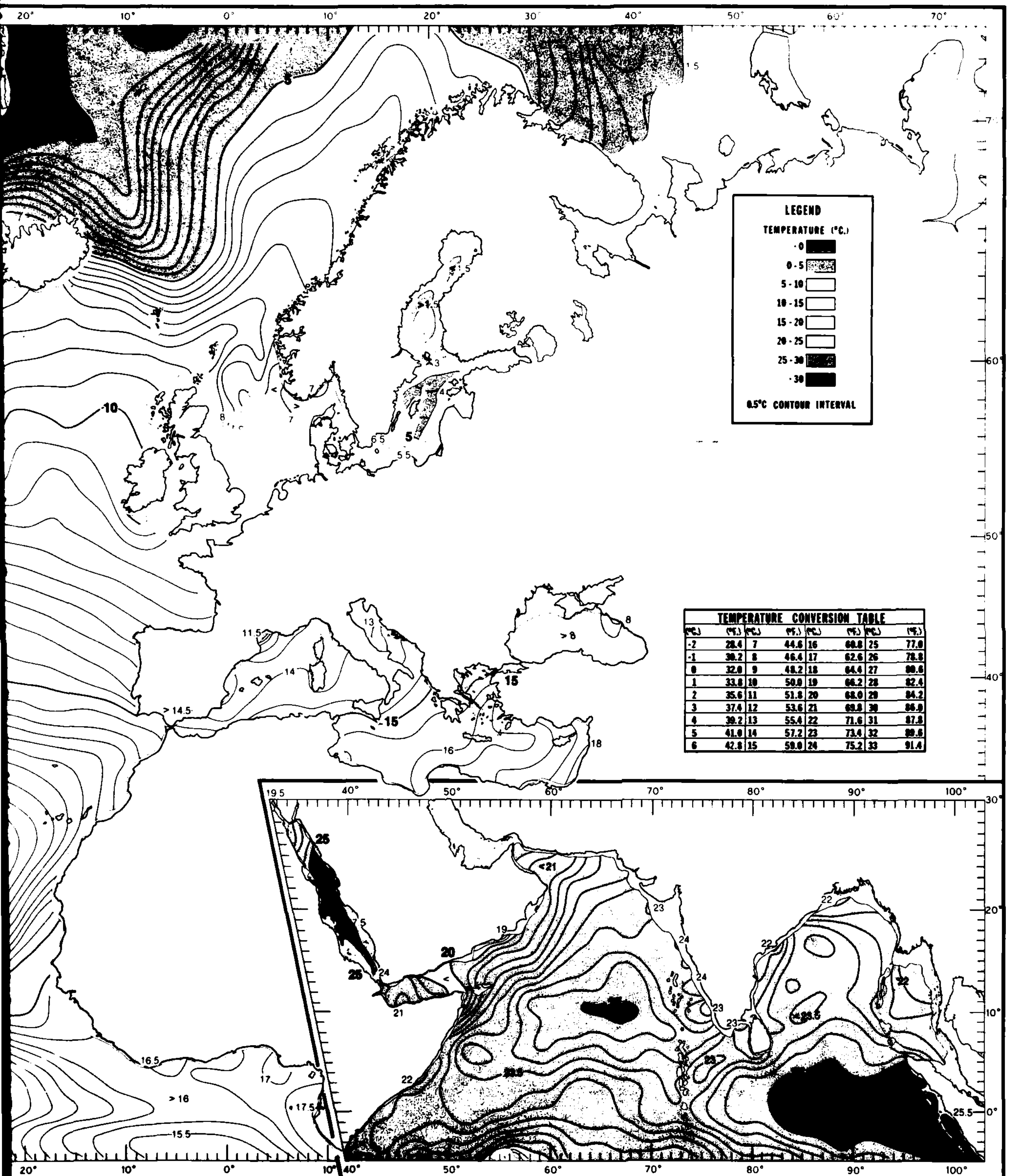


FIGURE 181. ANNUAL MEAN TEMPERATURES AT 300 FT (90 M)



TEMPERATURE CONVERSION TABLE							
(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

AL MEAN TEMPERATURES AT 300 FT (90 M)

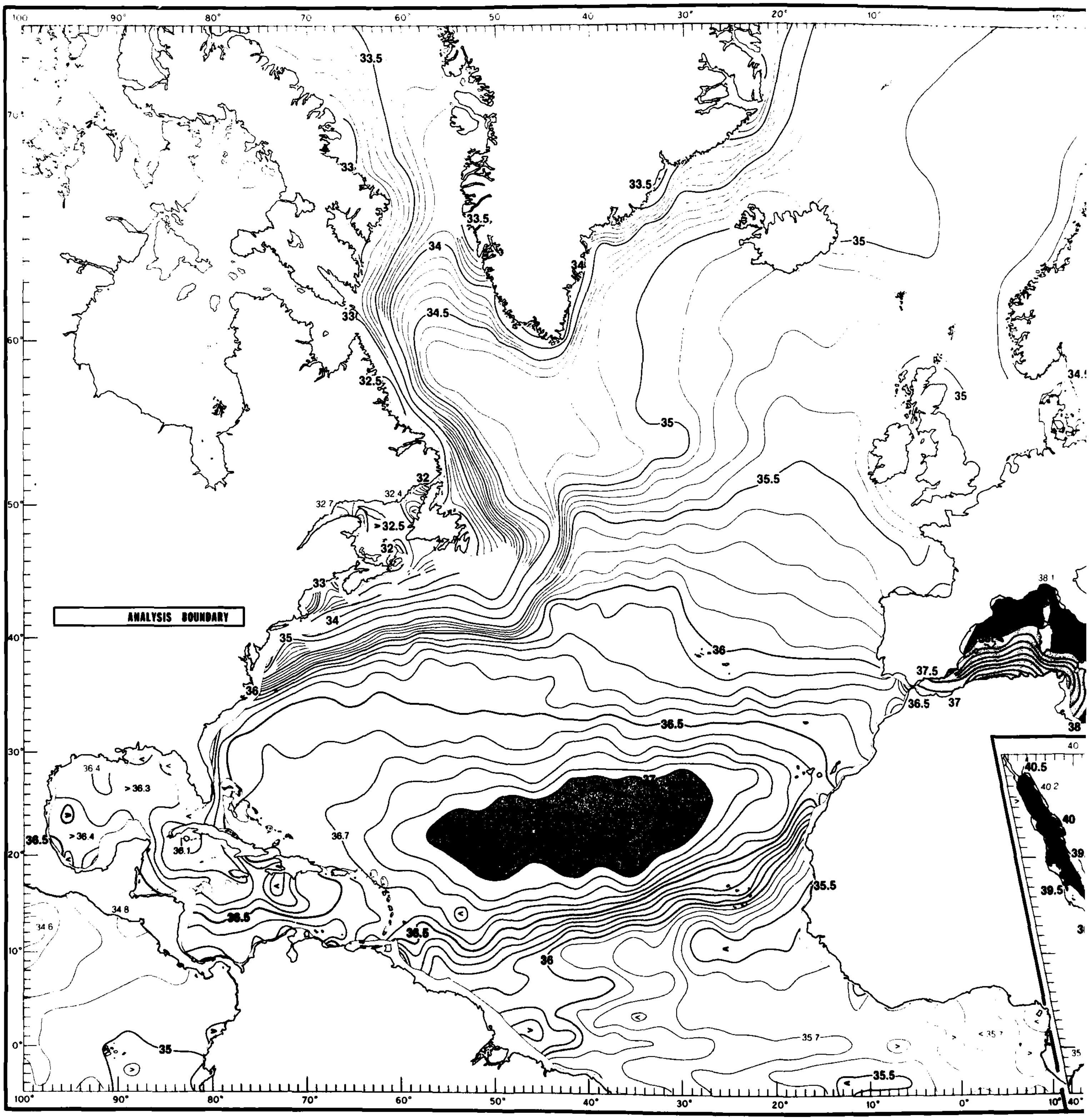
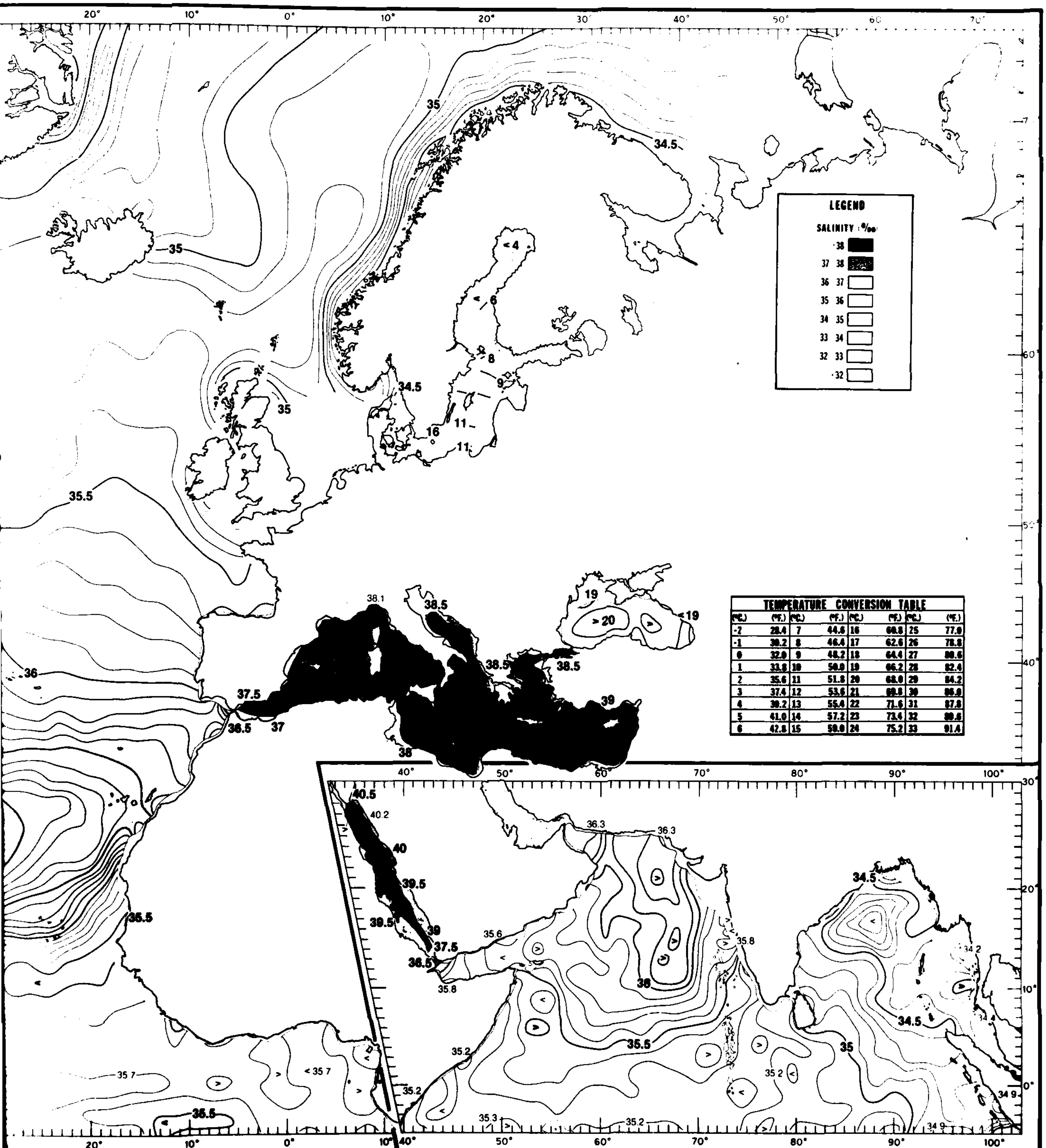


FIGURE 182. ANNUAL MEAN SALINITIES AT 300 FT (90 M)



TEMPERATURE CONVERSION TABLE							
(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

182. ANNUAL MEAN SALINITIES AT 300 FT (90 M)

2

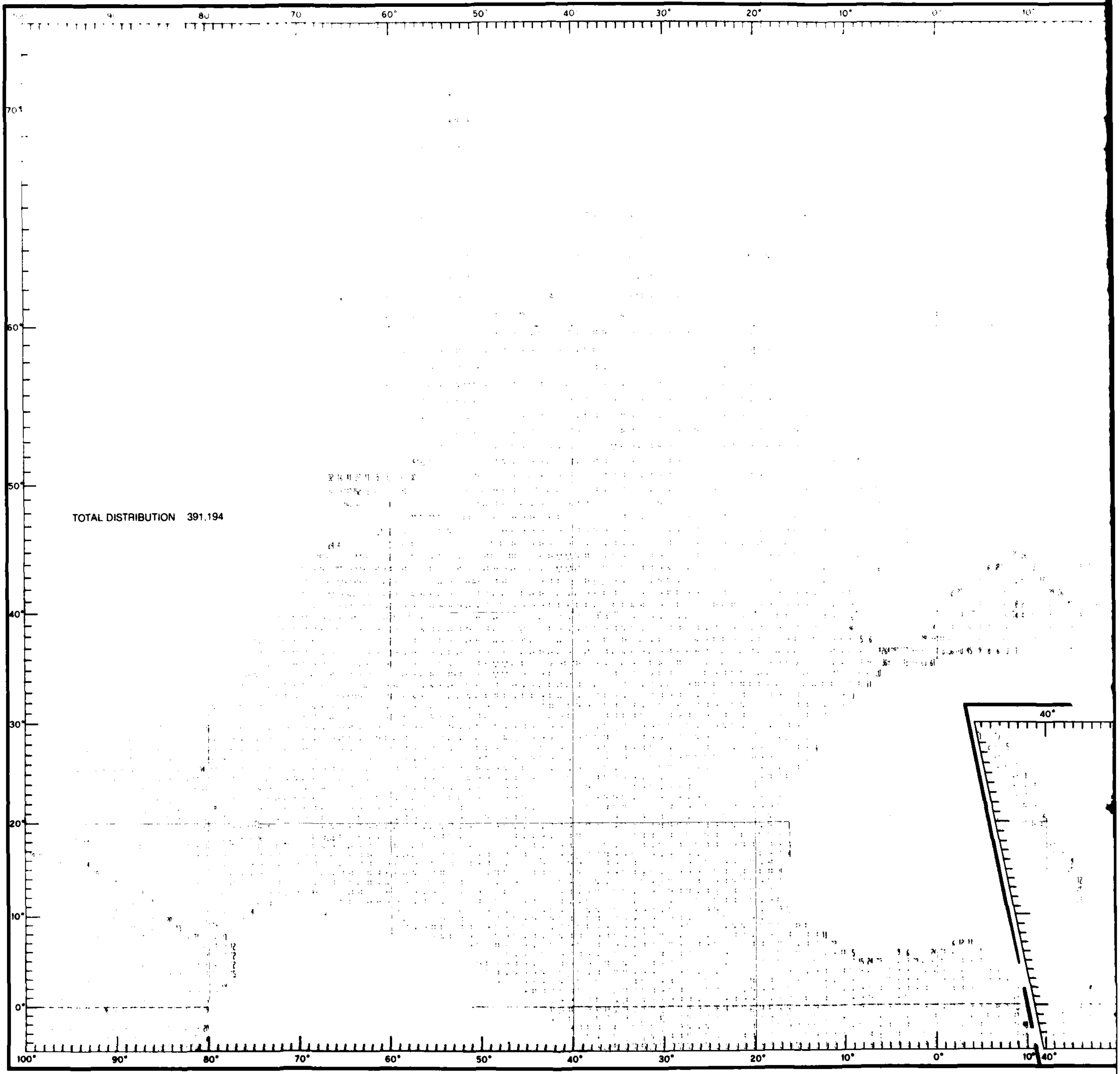
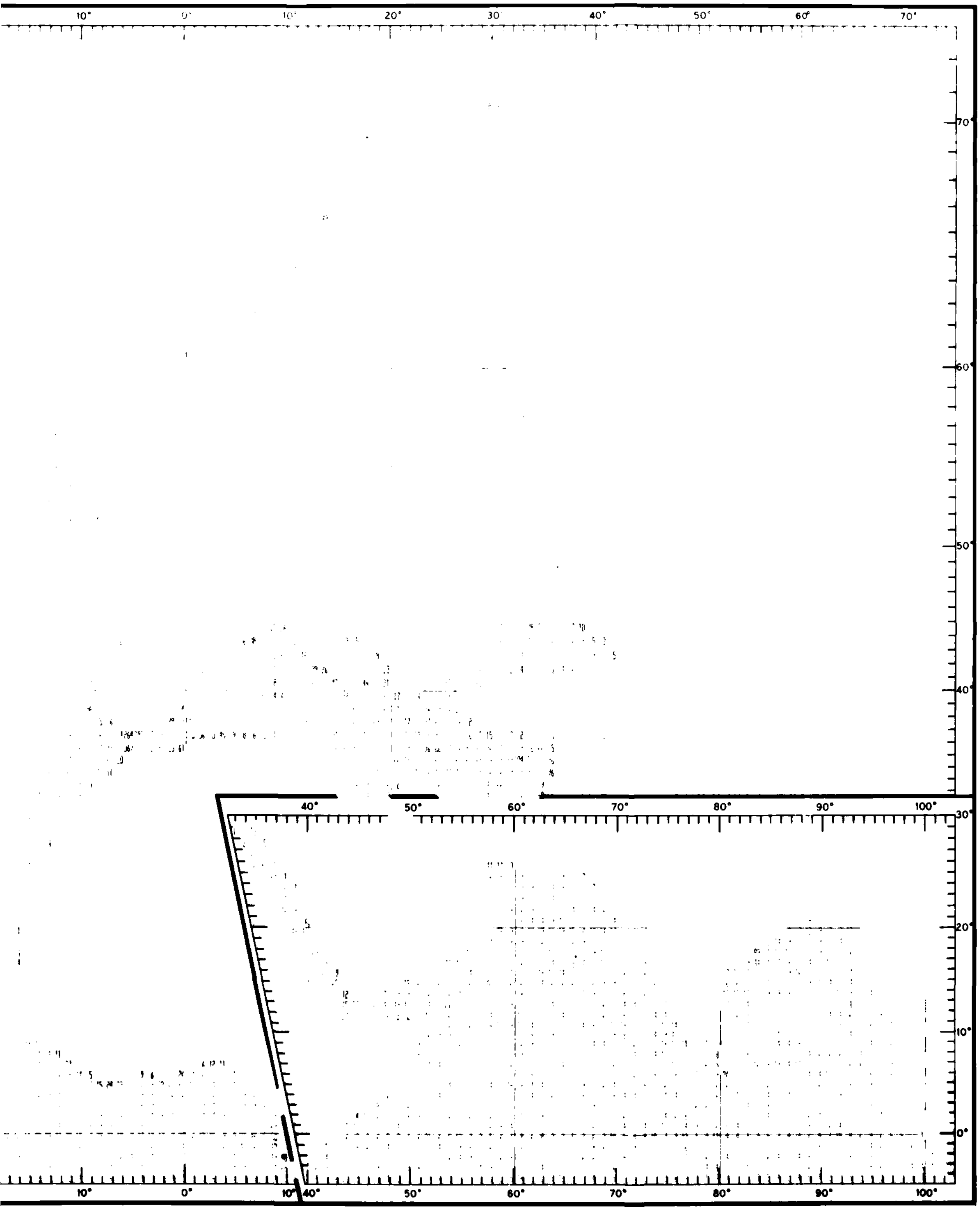


FIGURE 183. TOTAL DATA DISTRIBUTION OF TEMPERATURES AT 300 FT (90 M)

1



BUTION OF TEMPERATURES AT 300 FT (90 M)

1 2

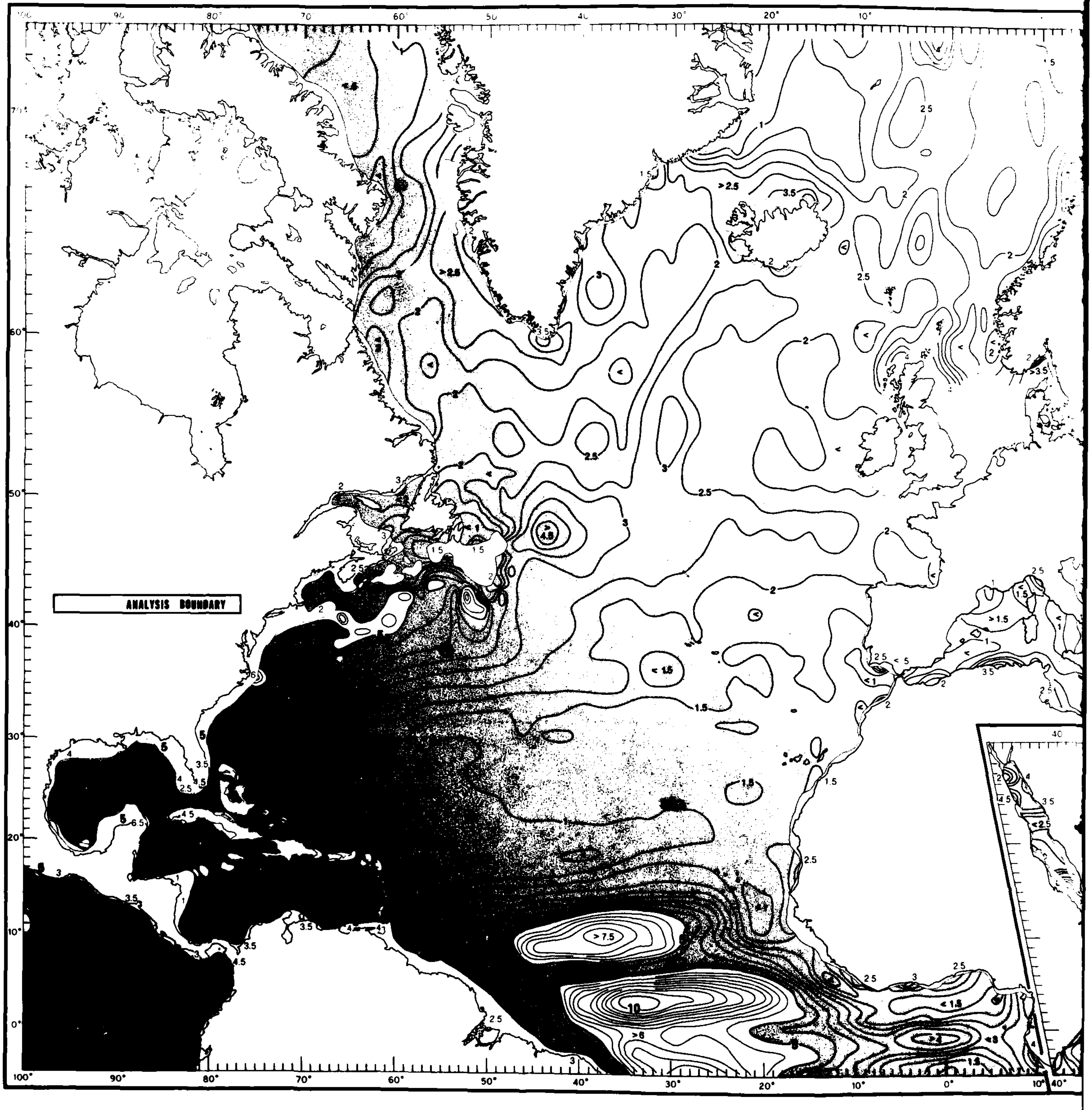
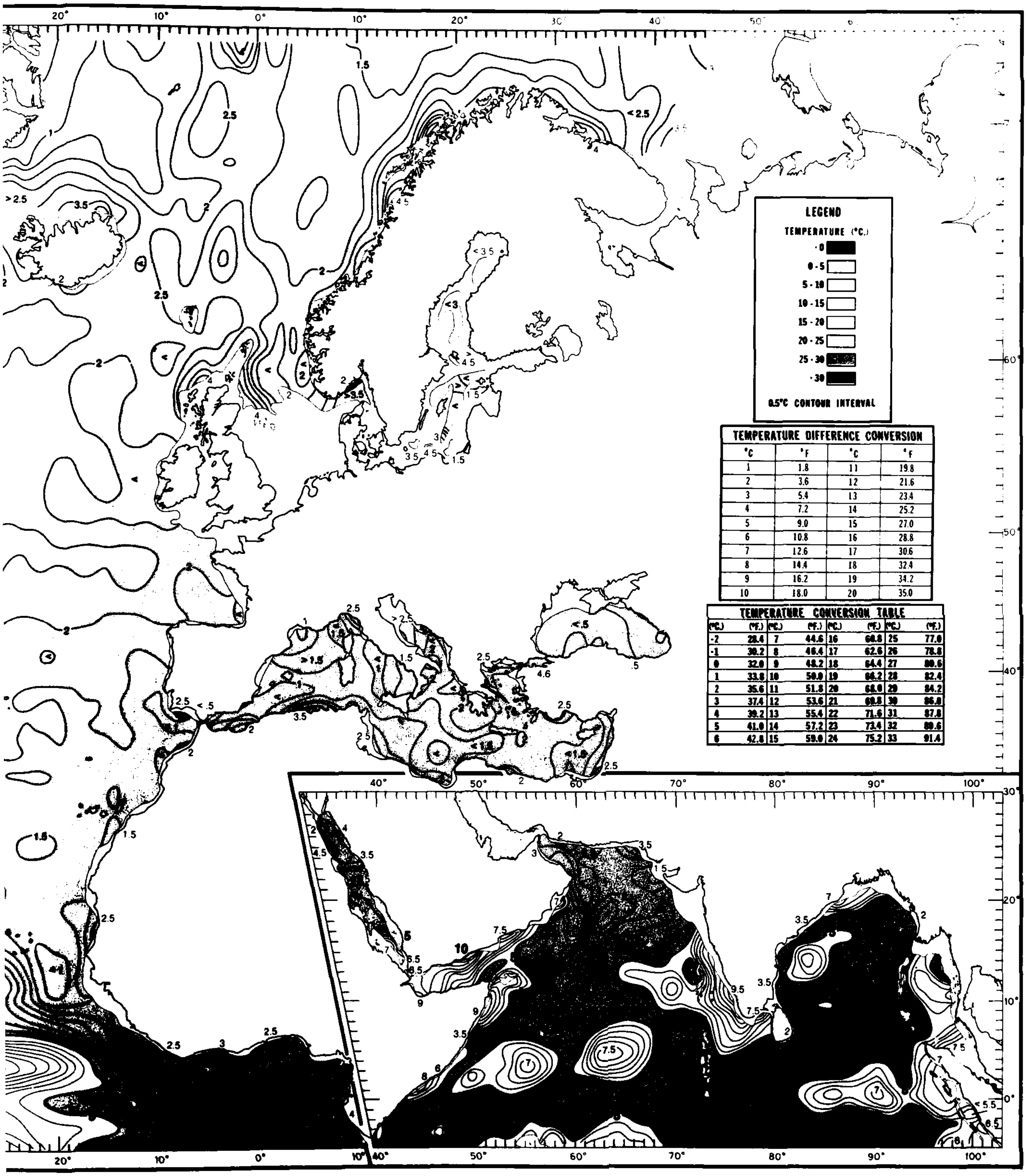


FIGURE 184. ANNUAL TEMPERATURE RANGE AT 300 FT (90 M)



TEMPERATURE DIFFERENCE CONVERSION

°C	°F	°C	°F
1	1.8	11	19.8
2	3.6	12	21.6
3	5.4	13	23.4
4	7.2	14	25.2
5	9.0	15	27.0
6	10.8	16	28.8
7	12.6	17	30.6
8	14.4	18	32.4
9	16.2	19	34.2
10	18.0	20	35.0

TEMPERATURE CONVERSION TABLE

(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

NUAL TEMPERATURE RANGE AT 300 FT (90 M)

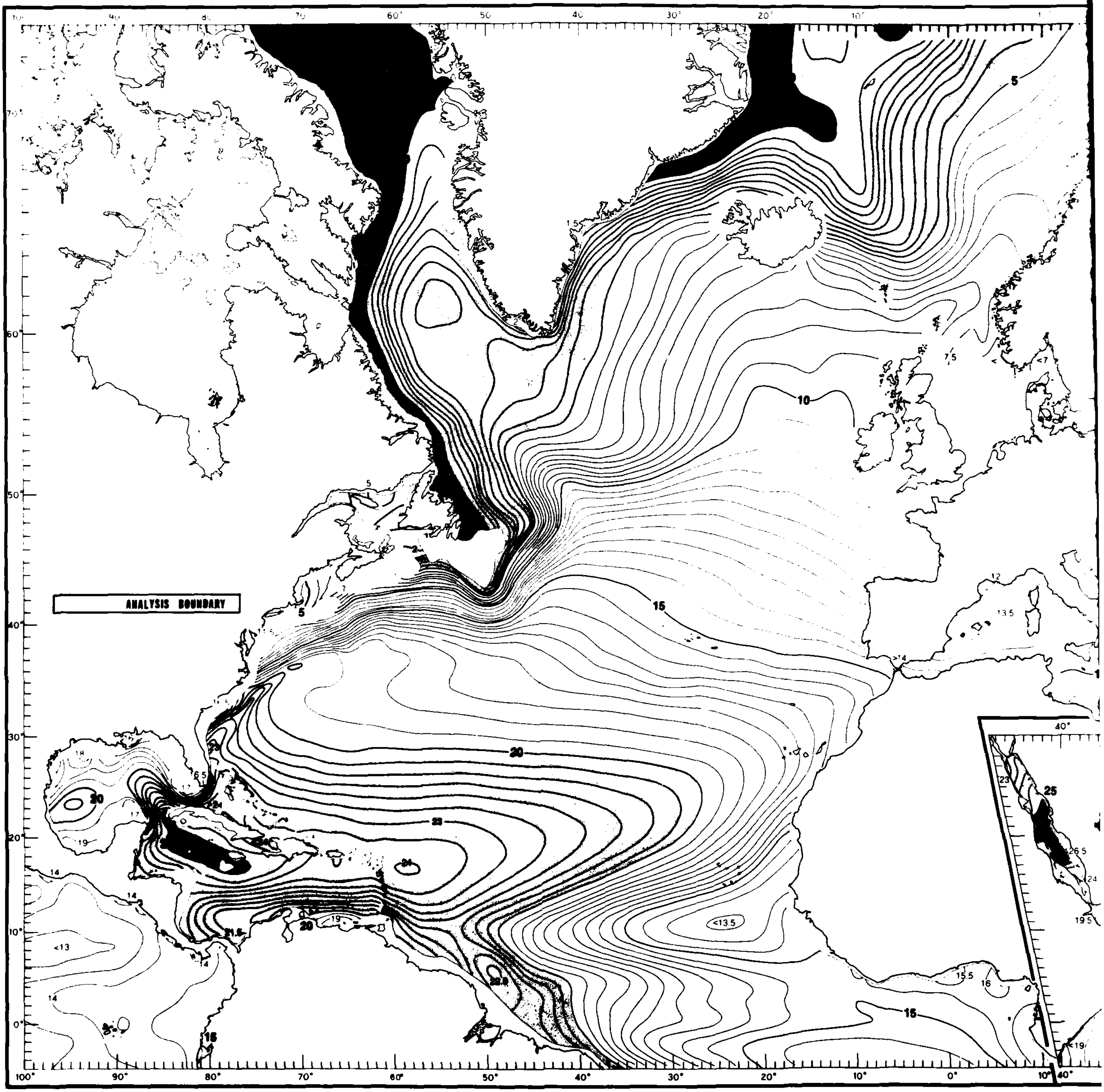
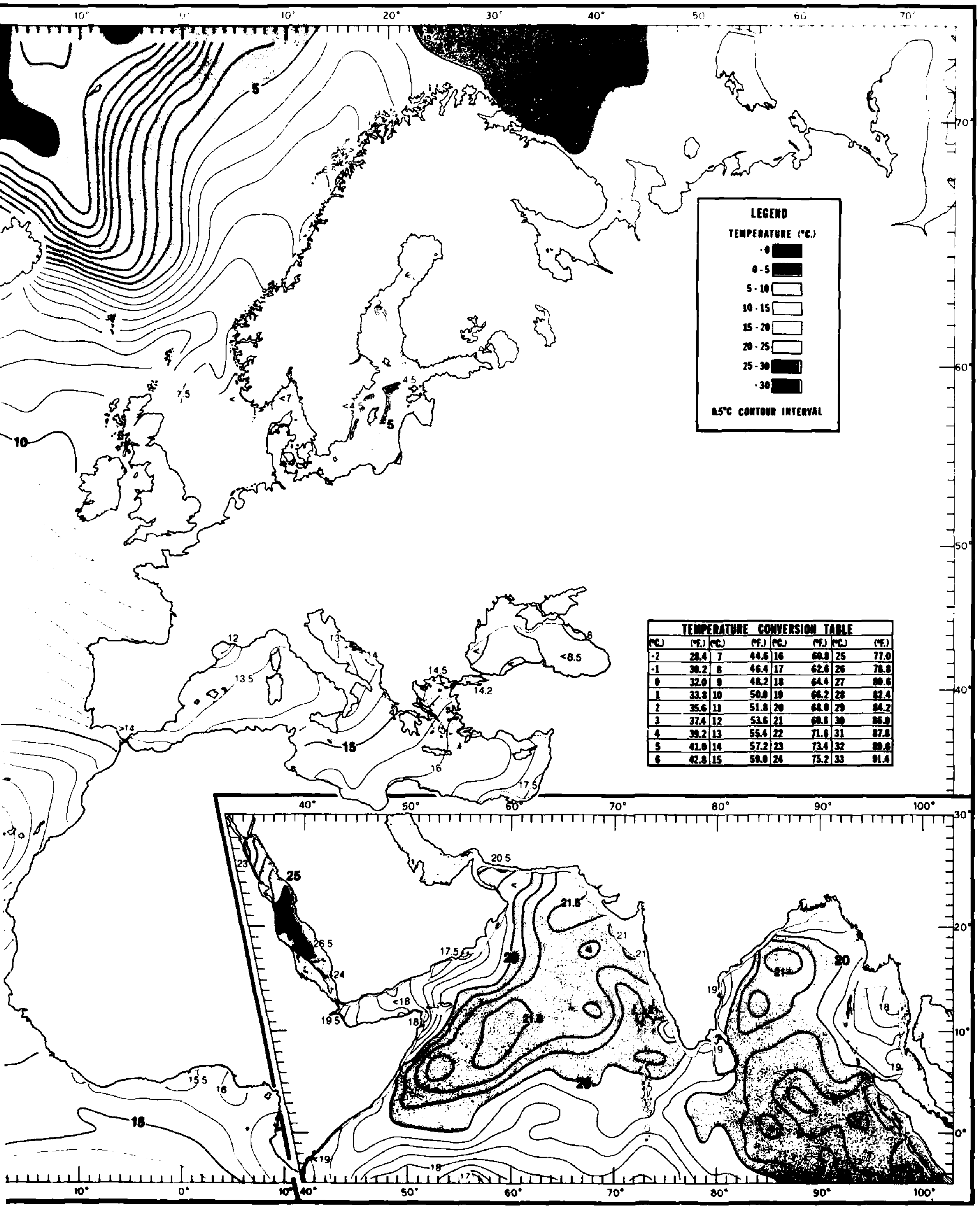


FIGURE 185. ANNUAL MEAN TEMPERATURES AT 400 FT (120 M)



TEMPERATURE CONVERSION TABLE							
(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

IATURES AT 400 FT (120 M)

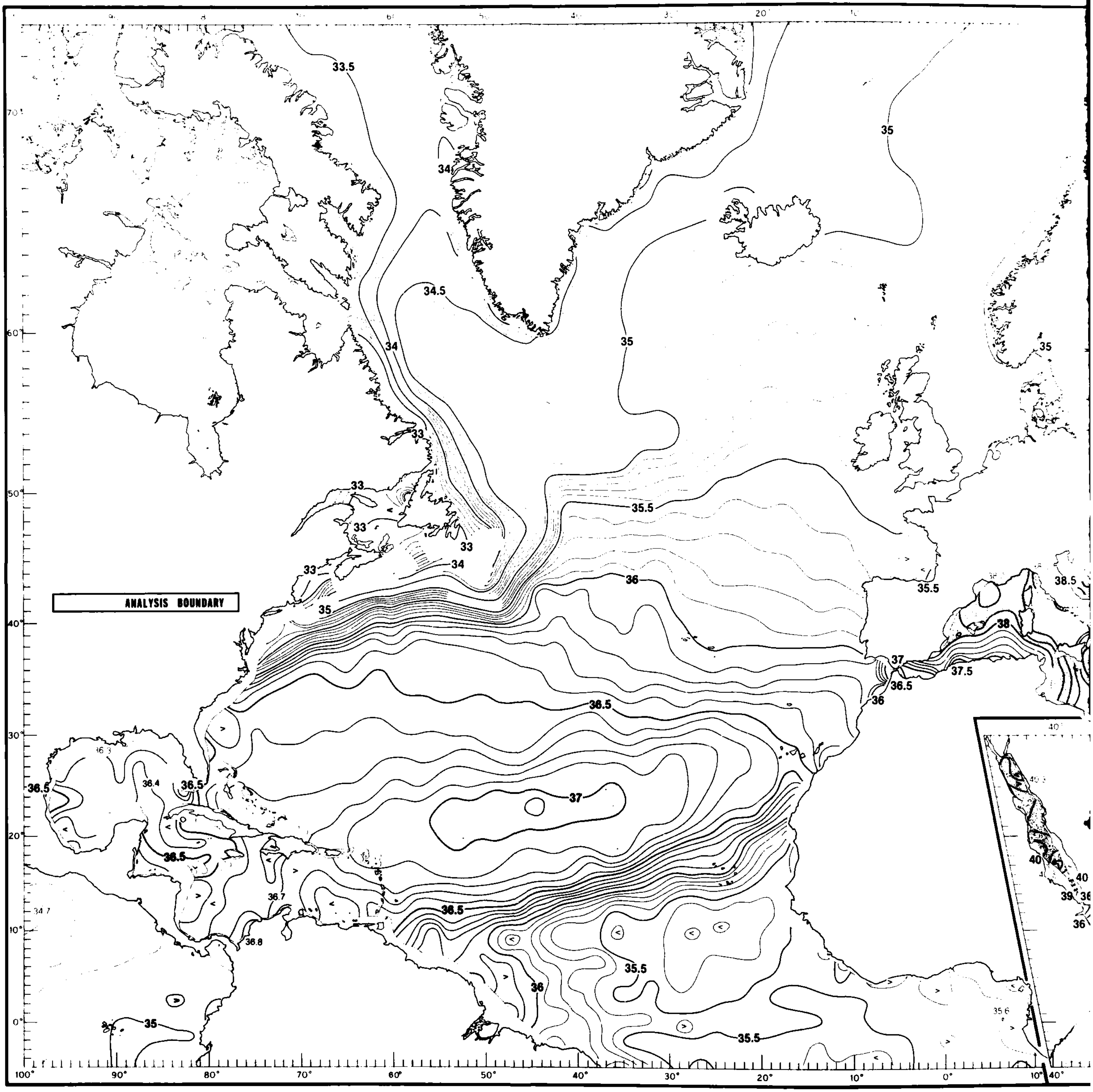
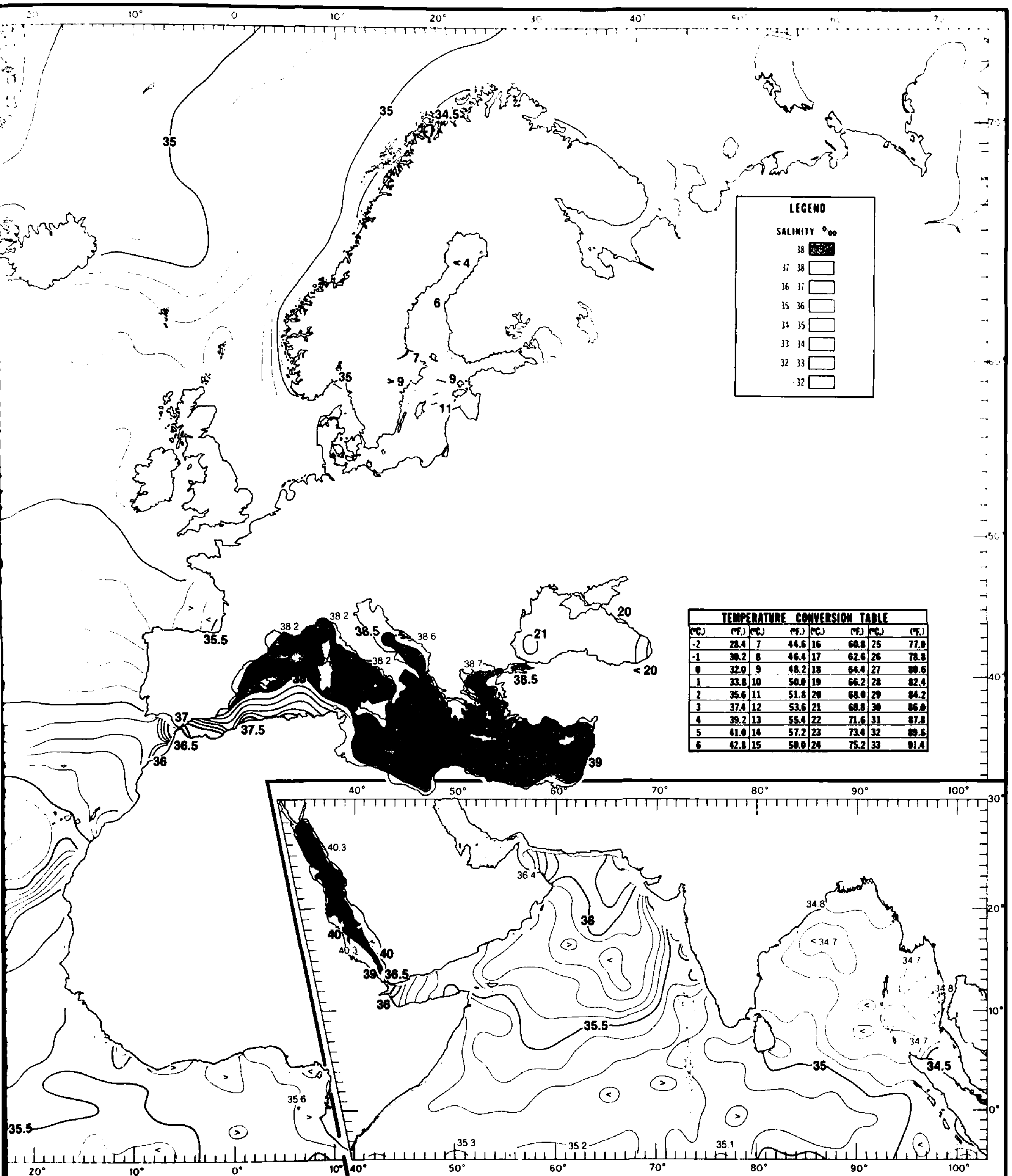


FIGURE 186. ANNUAL MEAN SALINITIES AT 400 FT (120 M)



TEMPERATURE CONVERSION TABLE							
(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

UAL MEAN SALINITIES AT 400 FT (120 M)

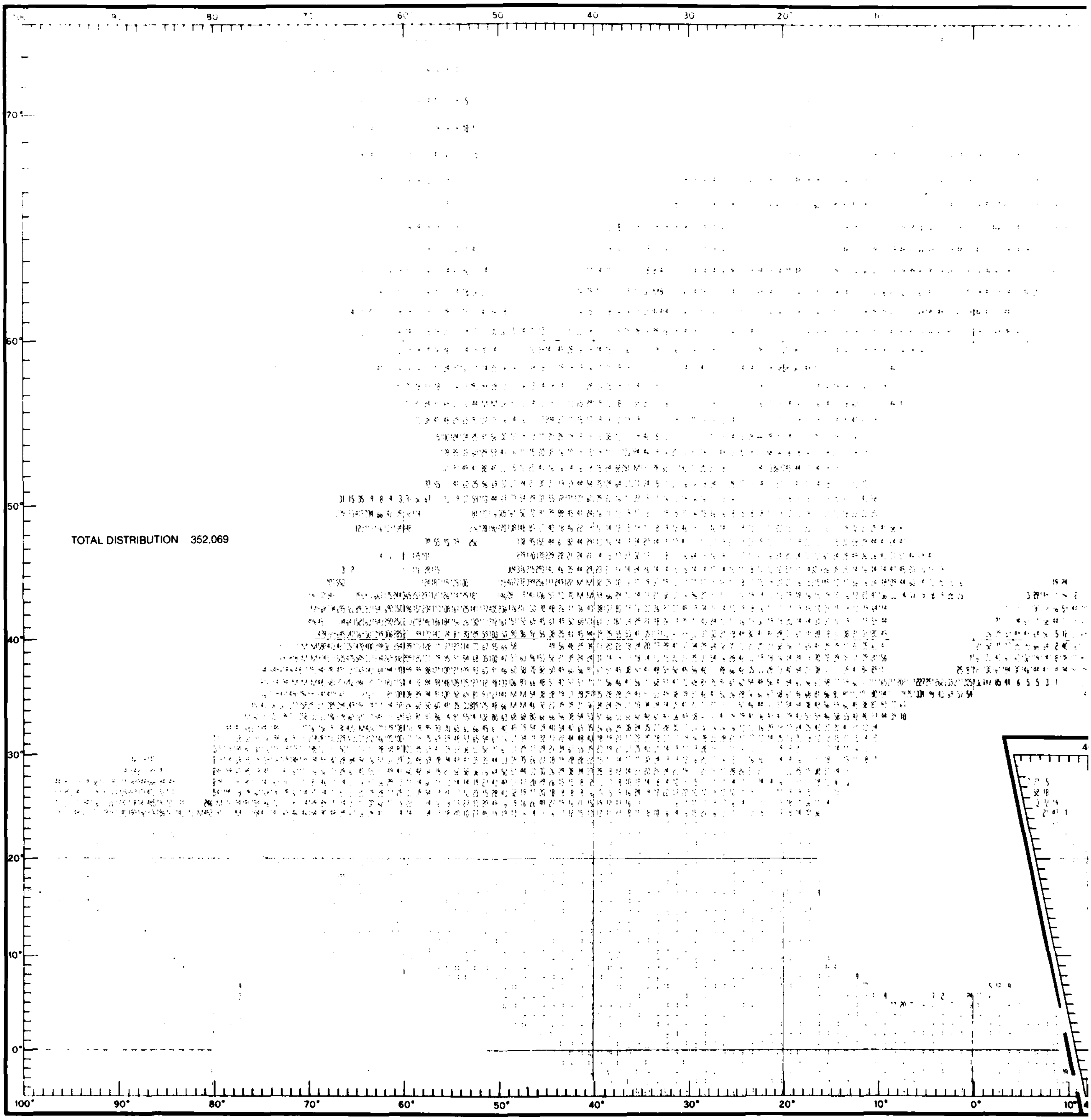
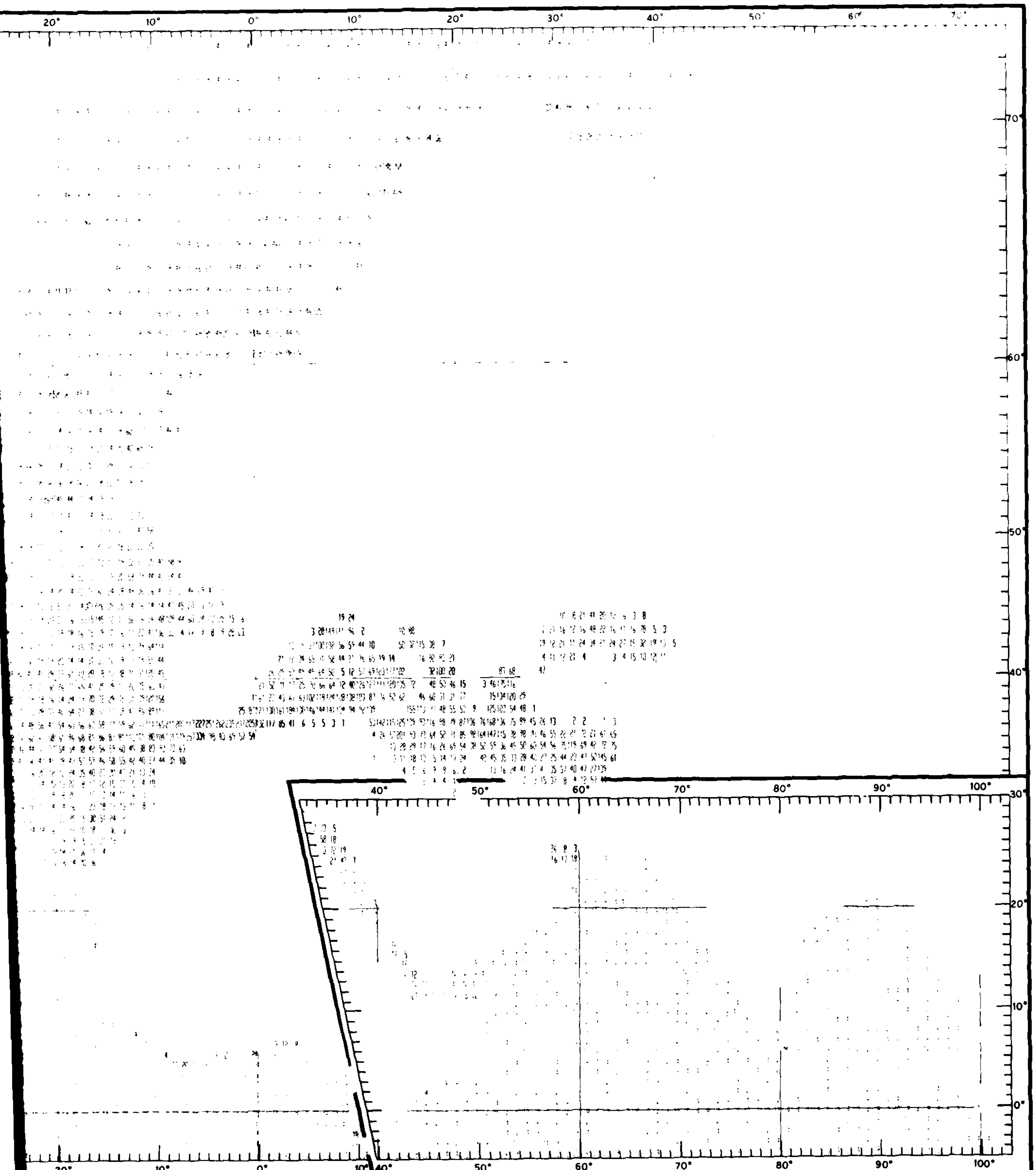


FIGURE 187. TOTAL DATA DISTRIBUTION OF TEMPERATURES AT 400 FT (1



DISTRIBUTION OF TEMPERATURES AT 400 FT (120 M)

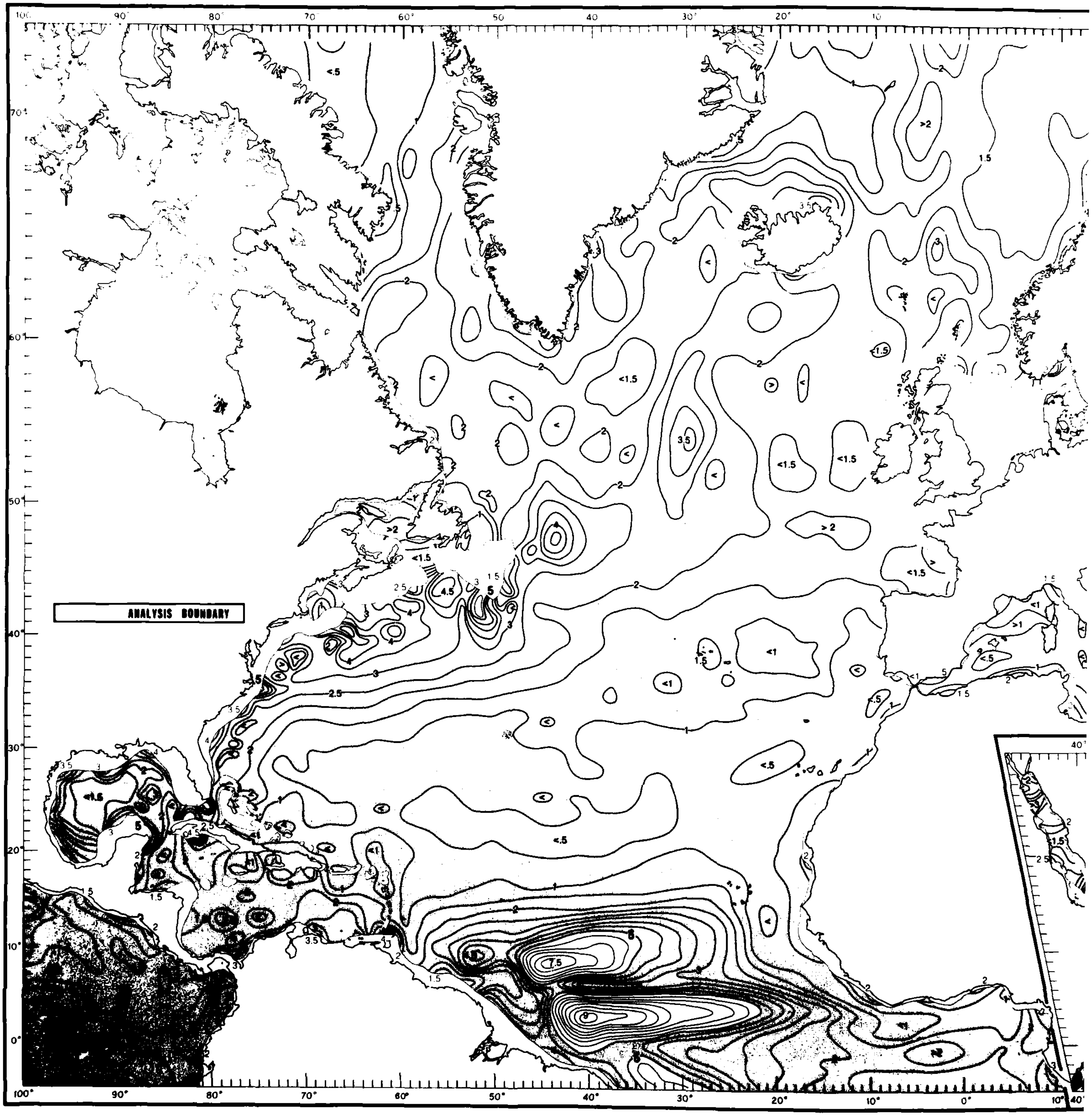
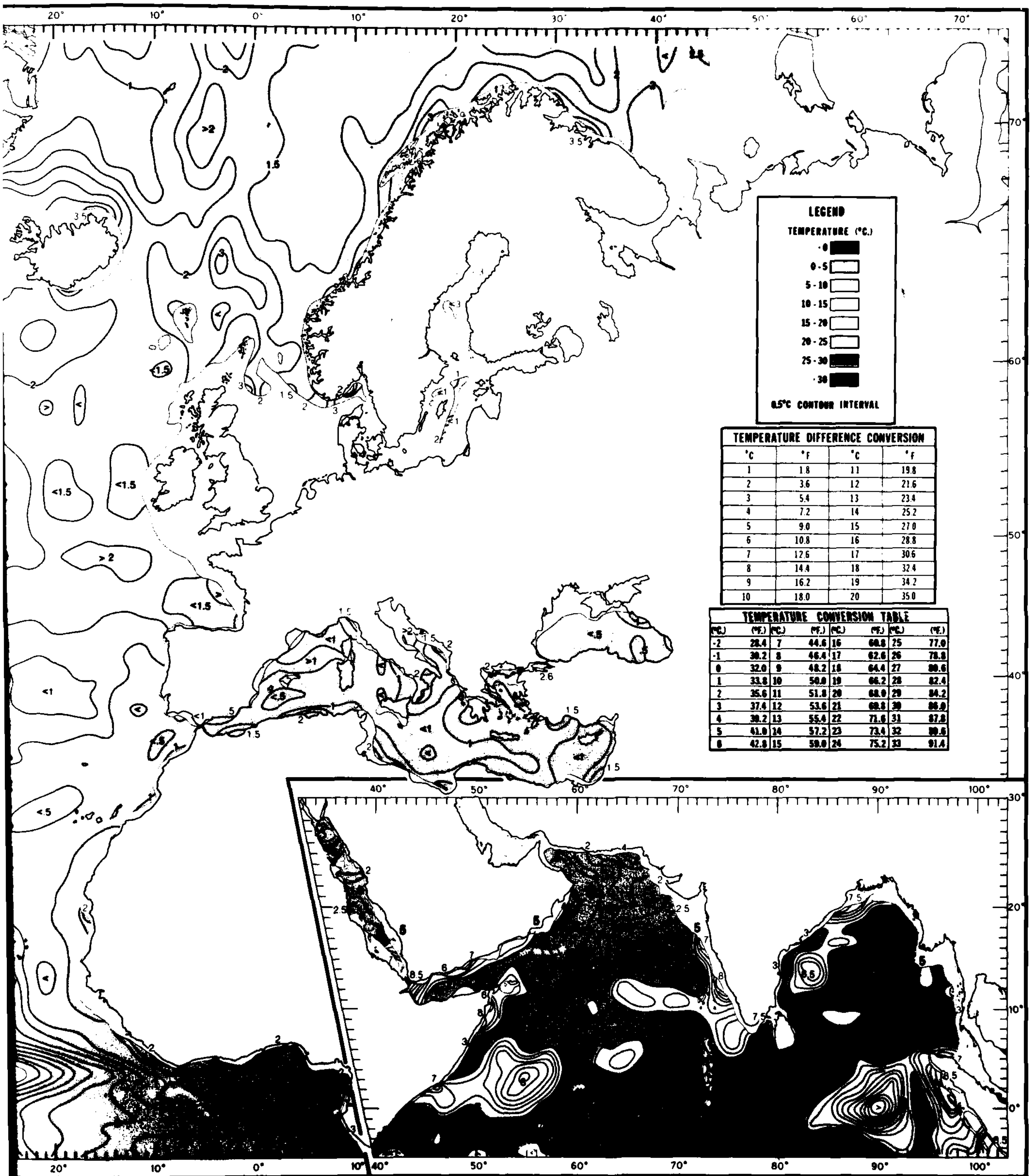


FIGURE 188. ANNUAL TEMPERATURE RANGE AT 400 FT (120 M)



TEMPERATURE DIFFERENCE CONVERSION

°C	°F	°C	°F
1	1.8	11	19.8
2	3.6	12	21.6
3	5.4	13	23.4
4	7.2	14	25.2
5	9.0	15	27.0
6	10.8	16	28.8
7	12.6	17	30.6
8	14.4	18	32.4
9	16.2	19	34.2
10	18.0	20	35.0

TEMPERATURE CONVERSION TABLE

(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

...AL TEMPERATURE RANGE AT 400 FT (120 M)

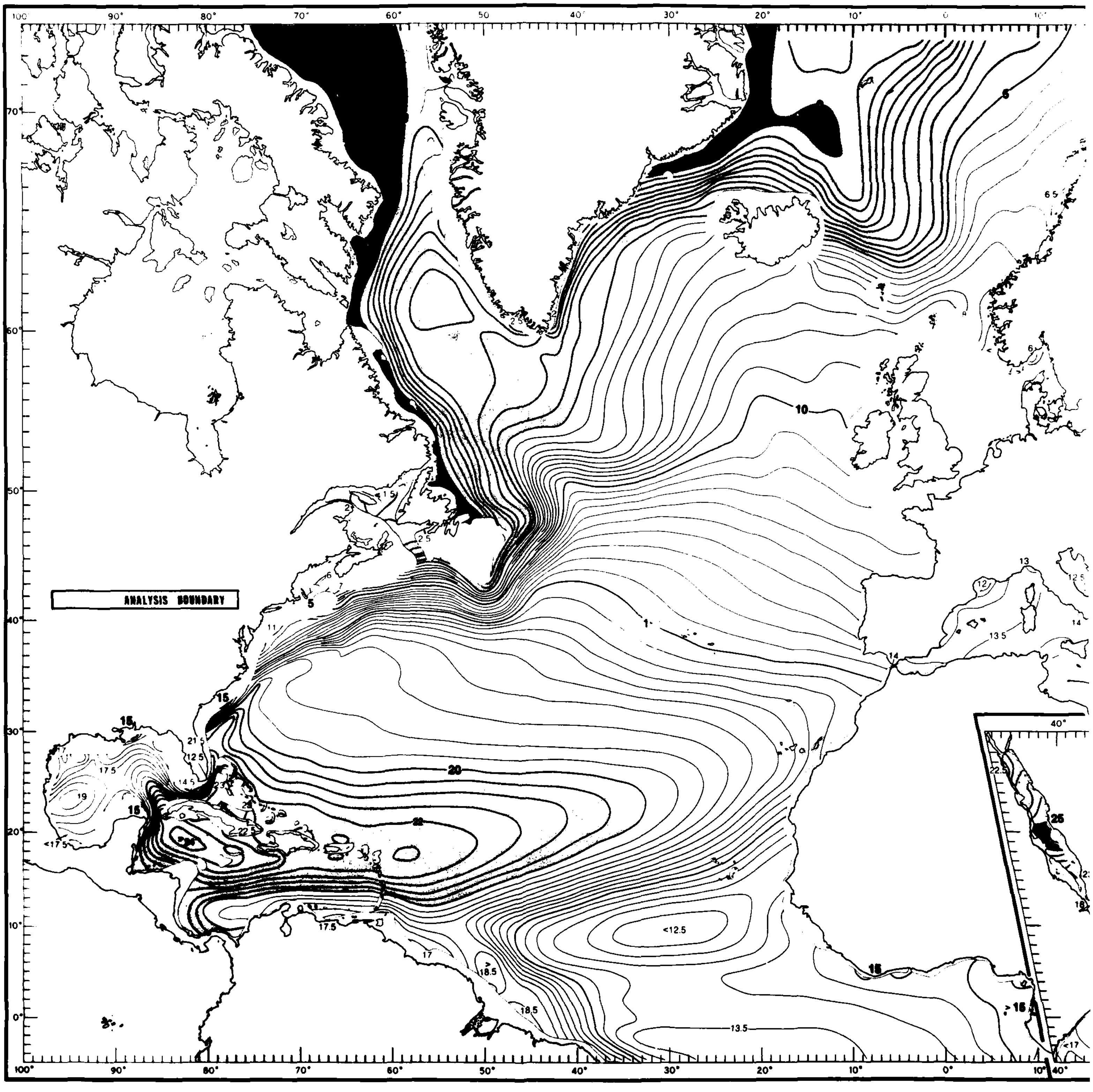
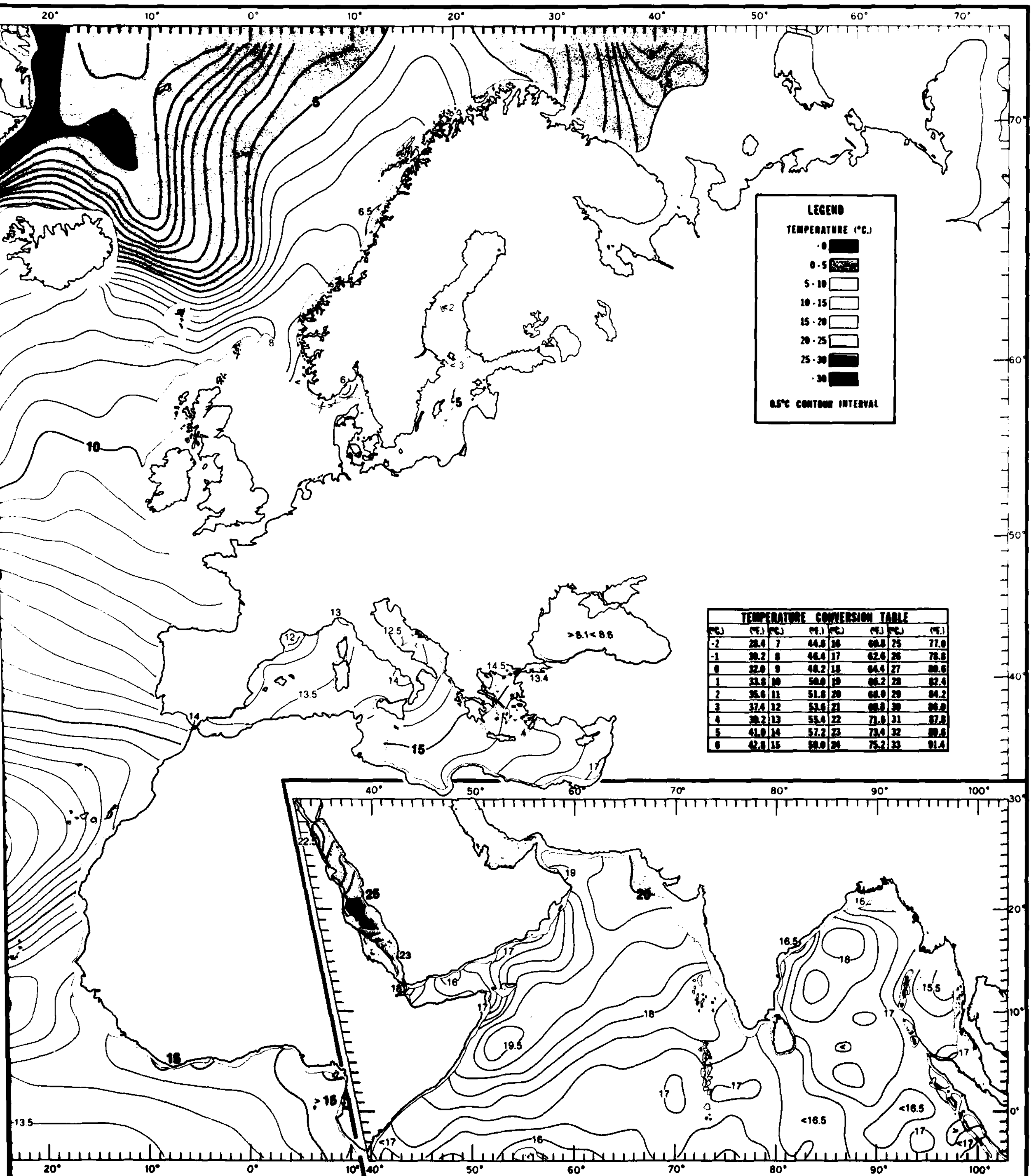


FIGURE 189. ANNUAL MEAN TEMPERATURES AT 492 FT (150 M)



TEMPERATURE CONVERSION TABLE

(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

AN TEMPERATURES AT 492 FT (150 M)

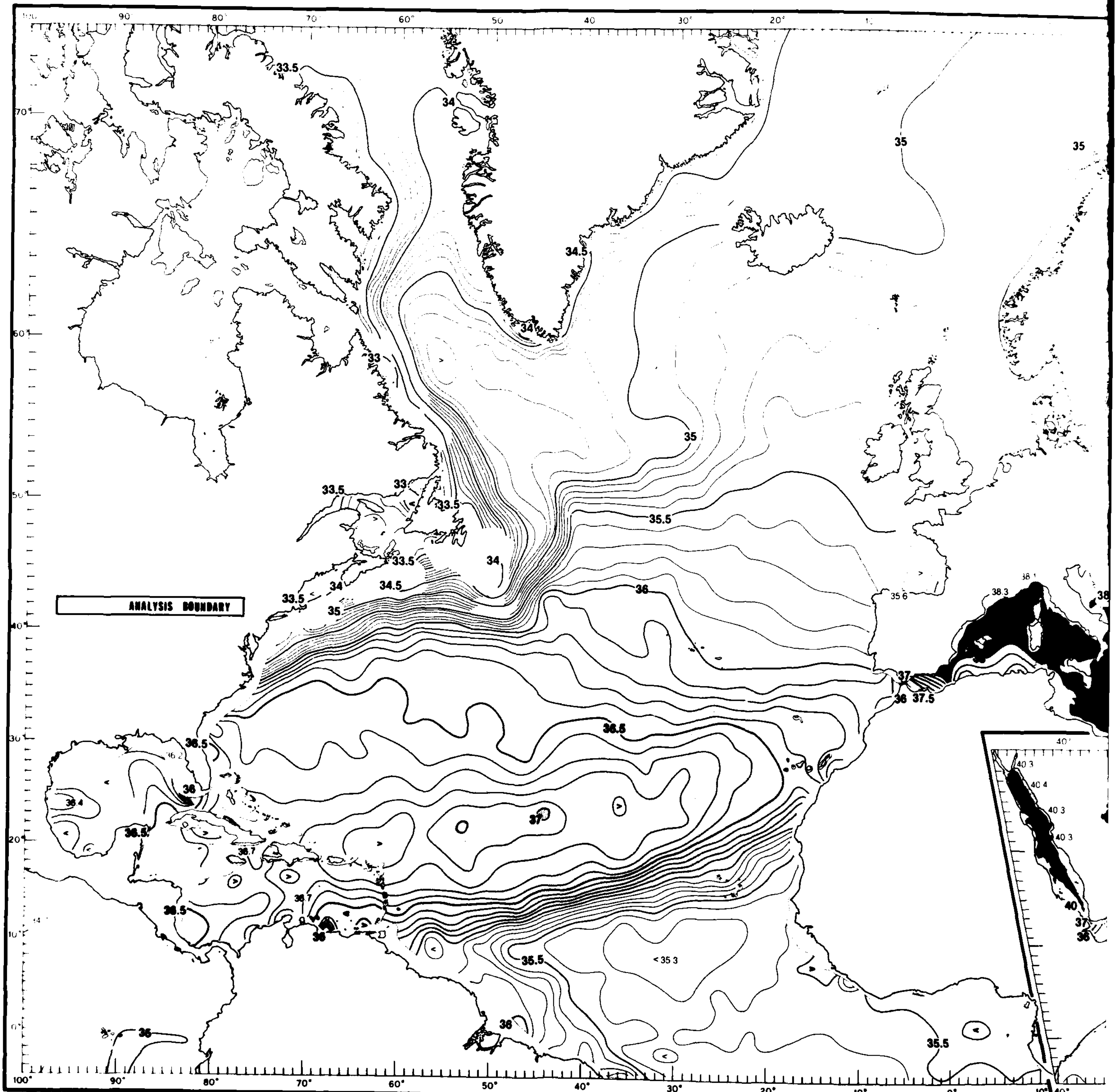
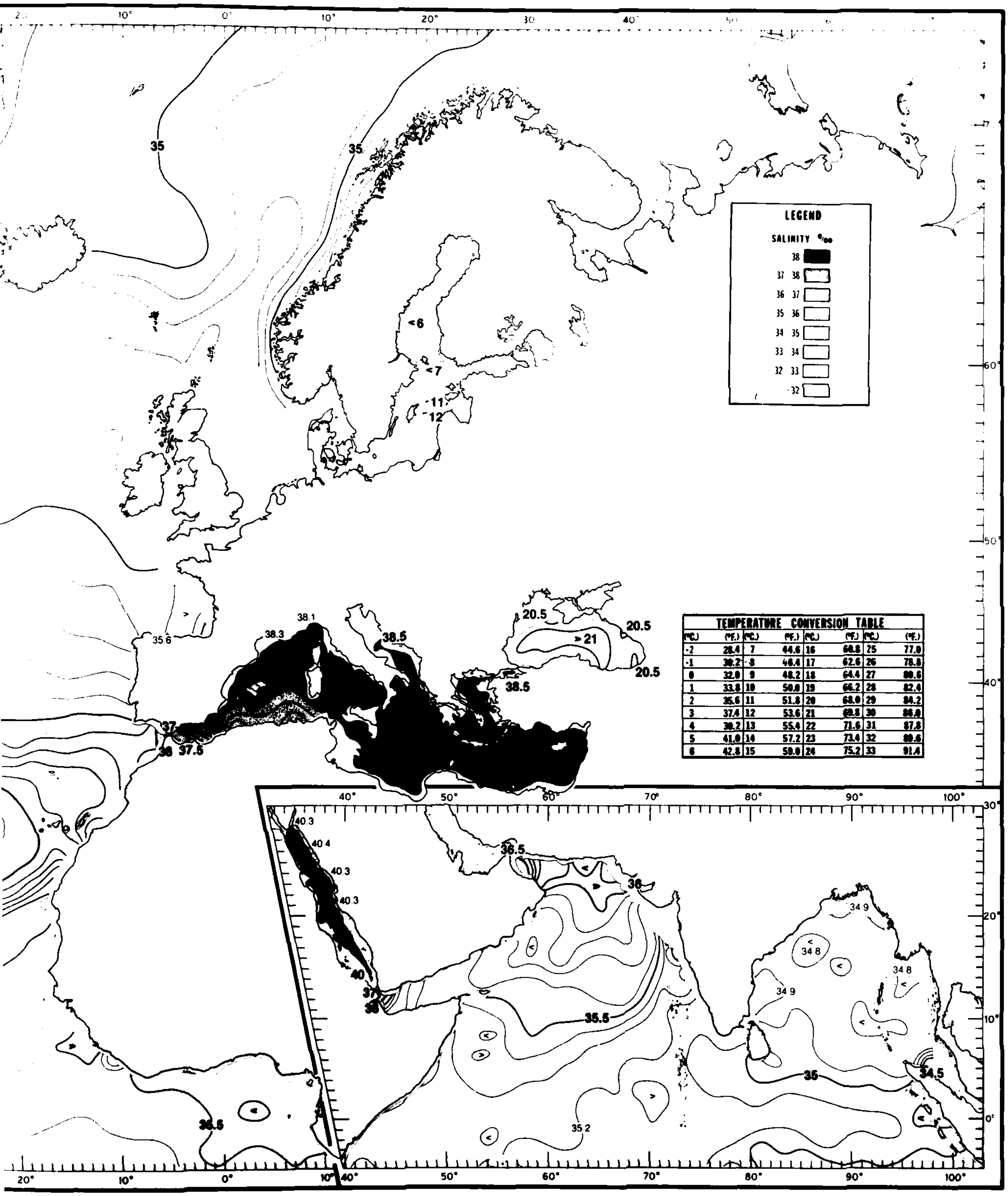


FIGURE 190. ANNUAL MEAN SALINITIES AT 492 FT (150 M)



TEMPERATURE CONVERSION TABLE							
(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

IAL MEAN SALINITIES AT 492 FT (150 M)

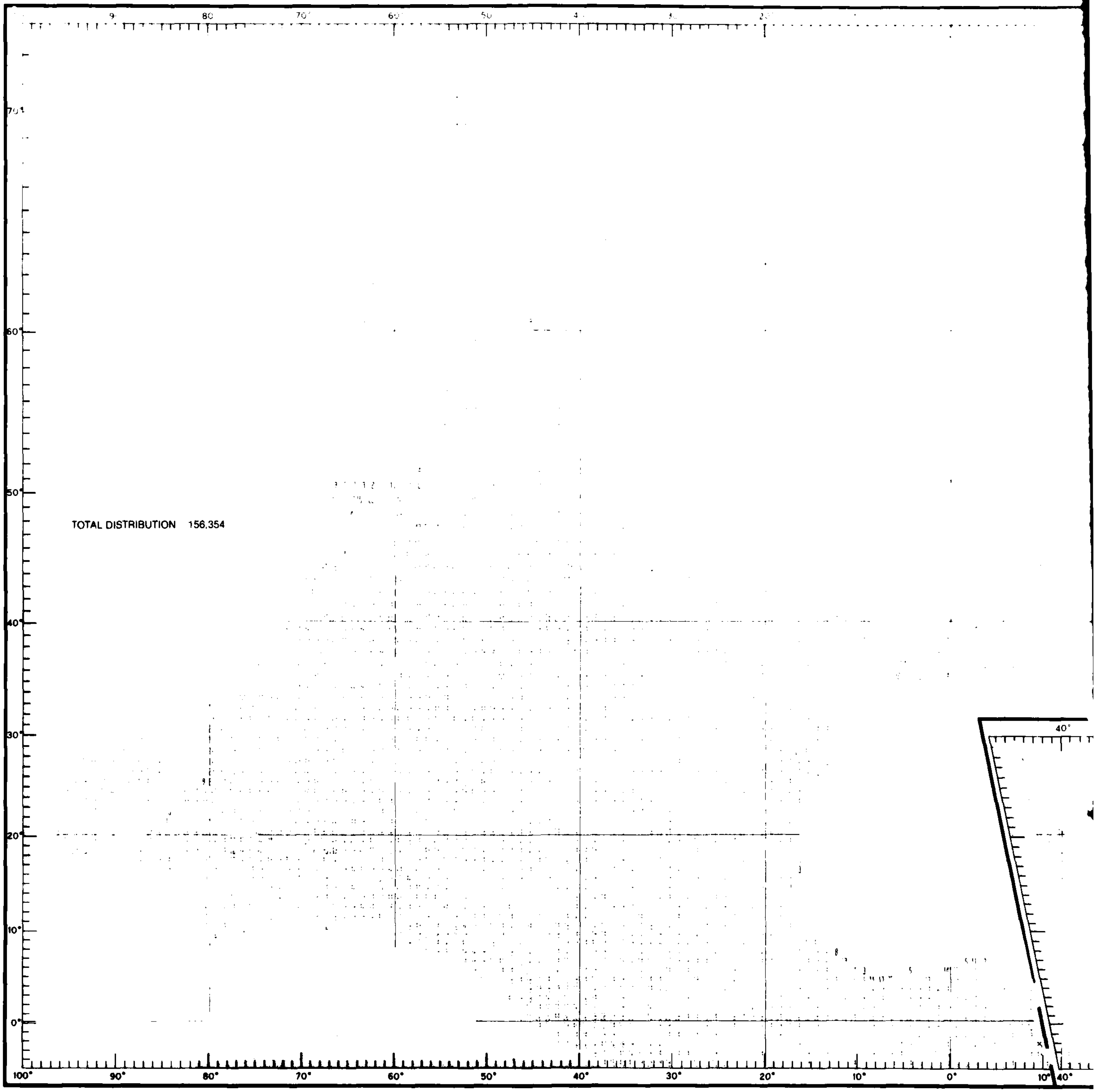
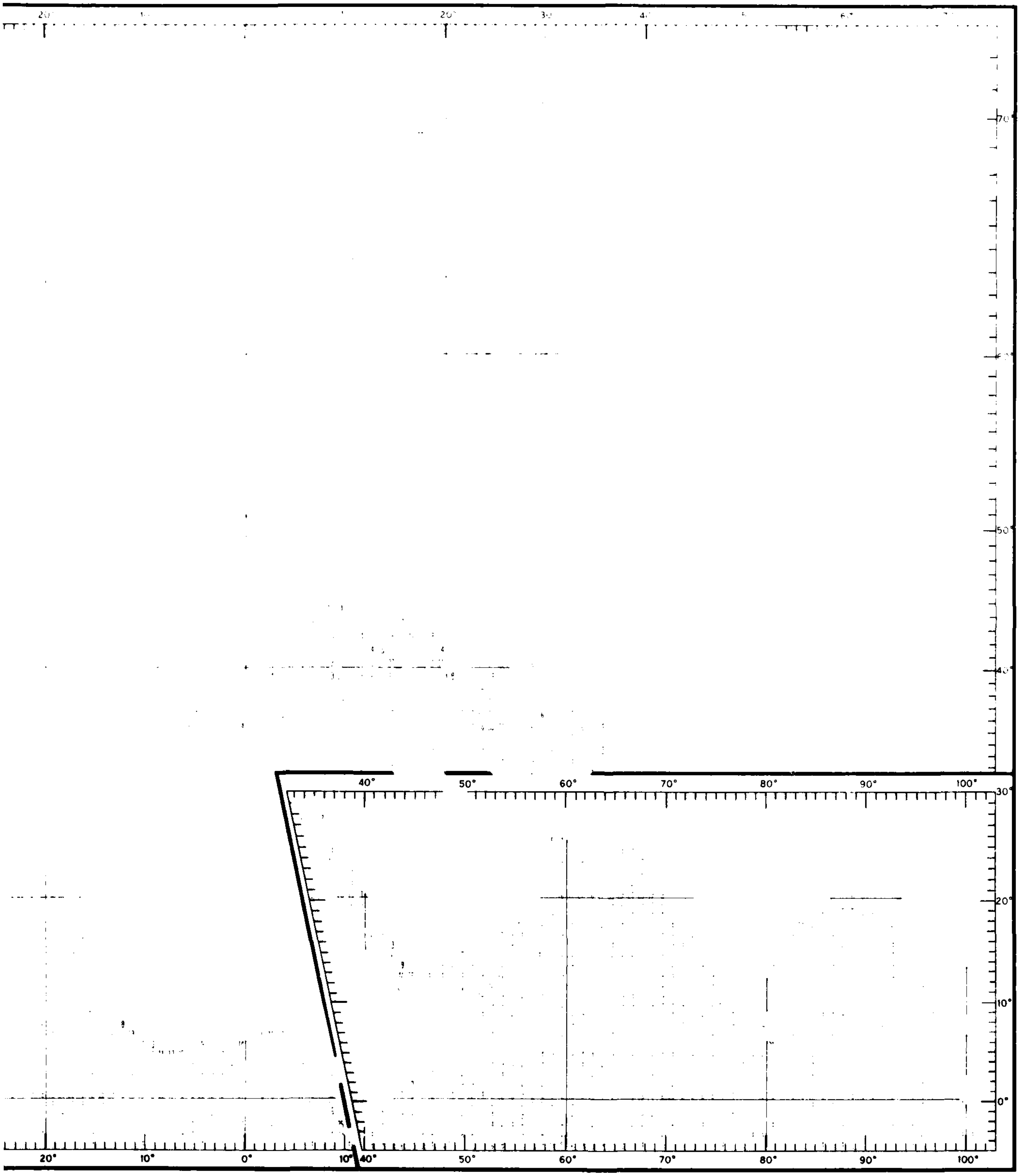


FIGURE 191. TOTAL DATA DISTRIBUTION OF TEMPERATURES AT 492 FT (150 M)



DISTRIBUTION OF TEMPERATURES AT 492 FT (150 M)

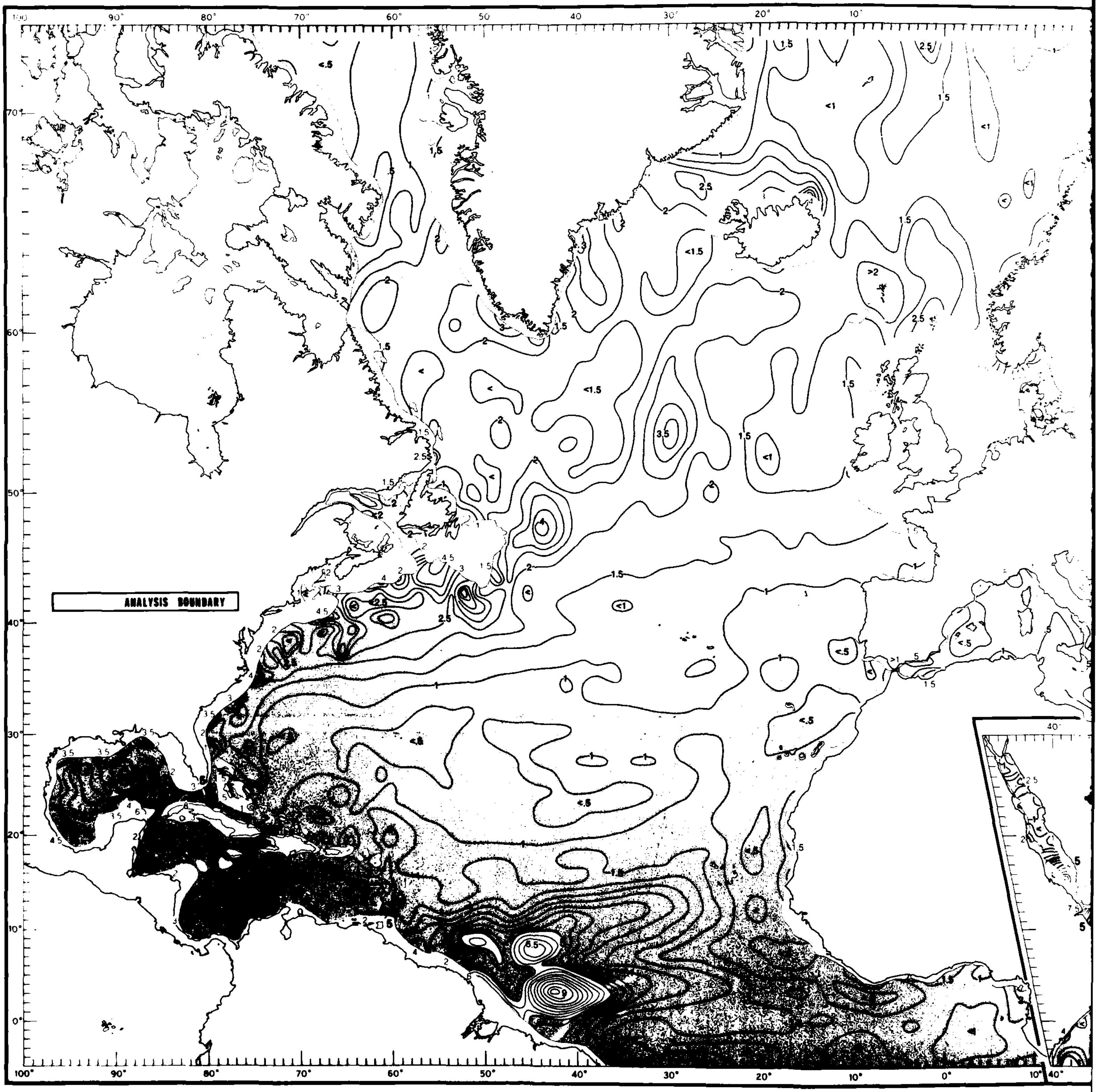
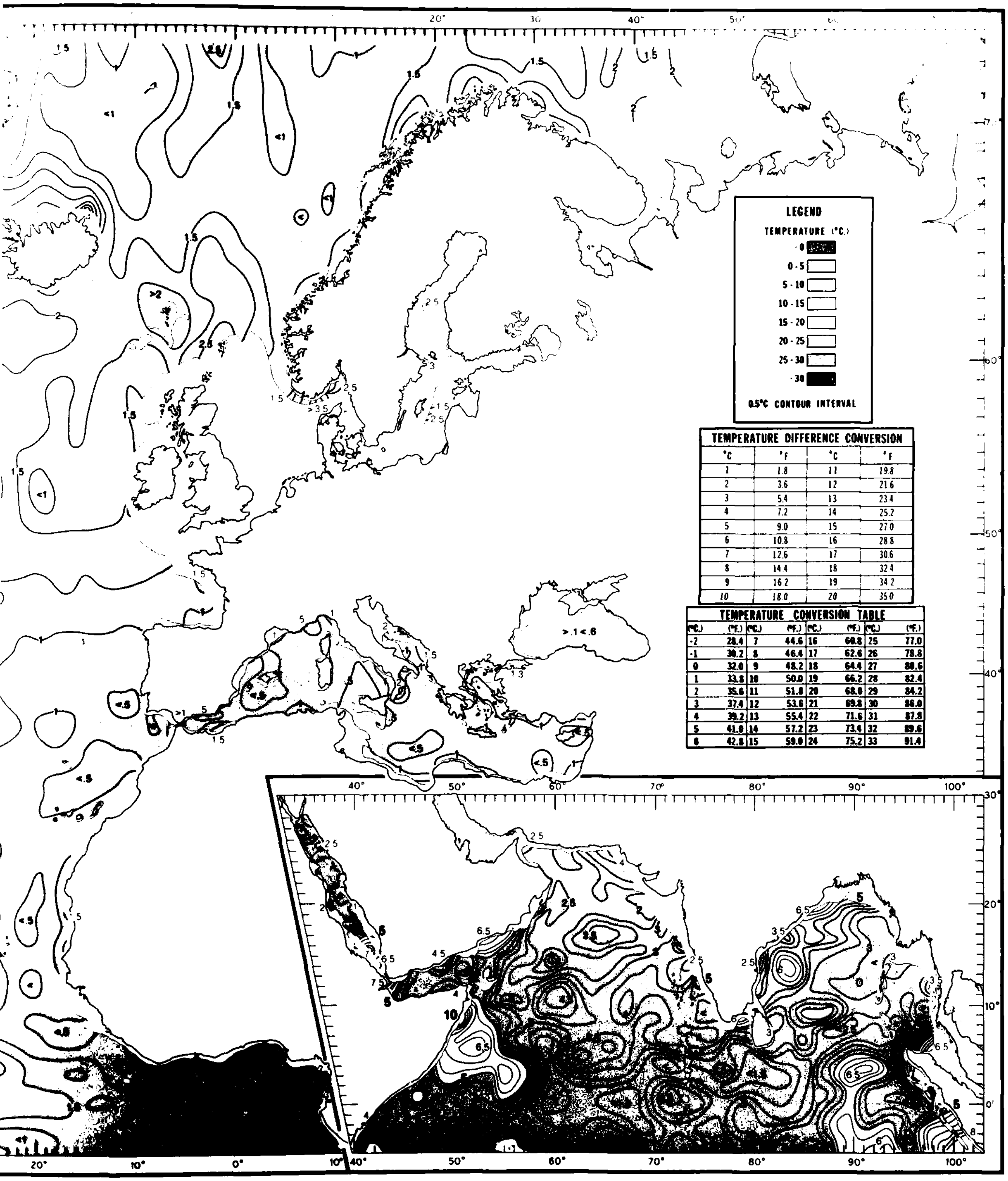


FIGURE 192. ANNUAL TEMPERATURE RANGE AT 492 FT (150 M)



TEMPERATURE DIFFERENCE CONVERSION

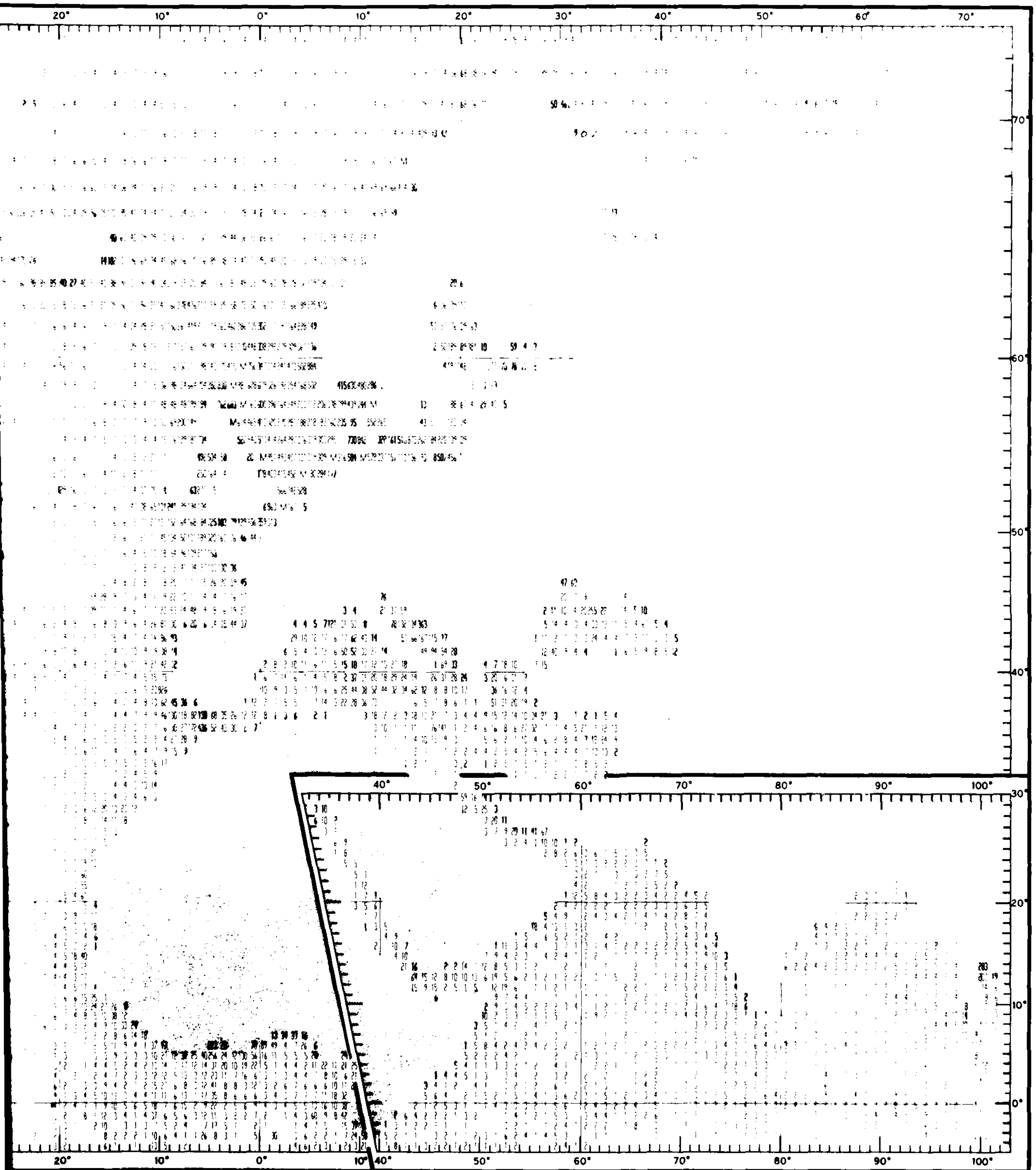
°C	°F	°C	°F
1	1.8	11	19.8
2	3.6	12	21.6
3	5.4	13	23.4
4	7.2	14	25.2
5	9.0	15	27.0
6	10.8	16	28.8
7	12.6	17	30.6
8	14.4	18	32.4
9	16.2	19	34.2
10	18.0	20	35.0

TEMPERATURE CONVERSION TABLE

(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

AL TEMPERATURE RANGE AT 492 FT (150 M)

FIGURE 193. TOTAL DATA DISTRIBUTION OF SALINITIES AT ALL LEVELS



DATA DISTRIBUTION OF SALINITIES AT ALL LEVELS

SOUTHERN INDIAN OCEAN

LEGEND

TEMPERATURE (°C.)

- ·0
- 0 - 5
- 5 - 10
- 10 - 15
- 15 - 20
- 20 - 25
- 25 - 30
- ·30

0.5°C CONTOUR INTERVAL

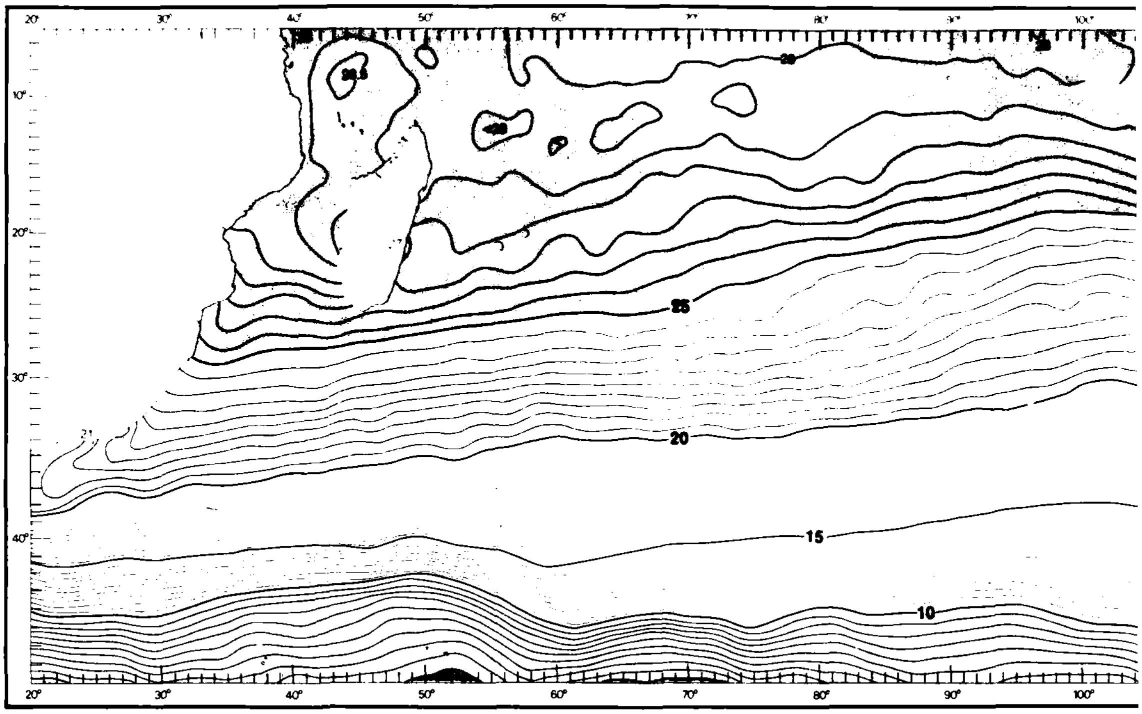


FIGURE 194. JANUARY SOUTH INDIAN OCEAN MEAN TEMPERATURES AT TH

TEMPERATURE CONVERSION TABLE							
(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

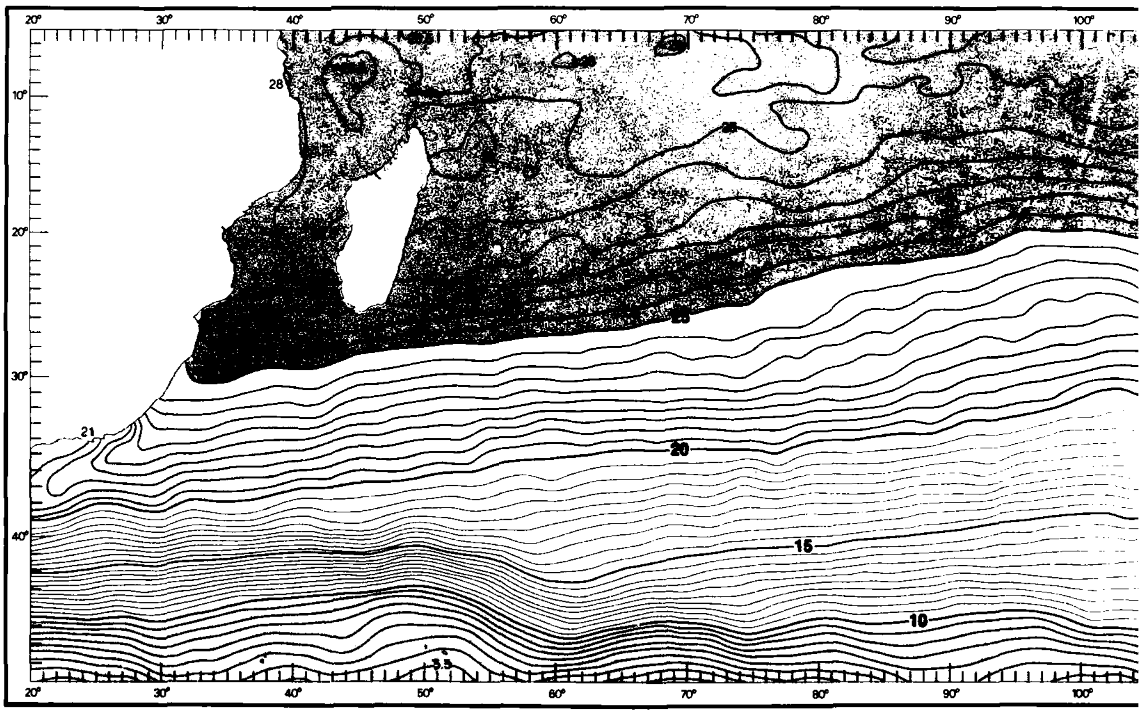
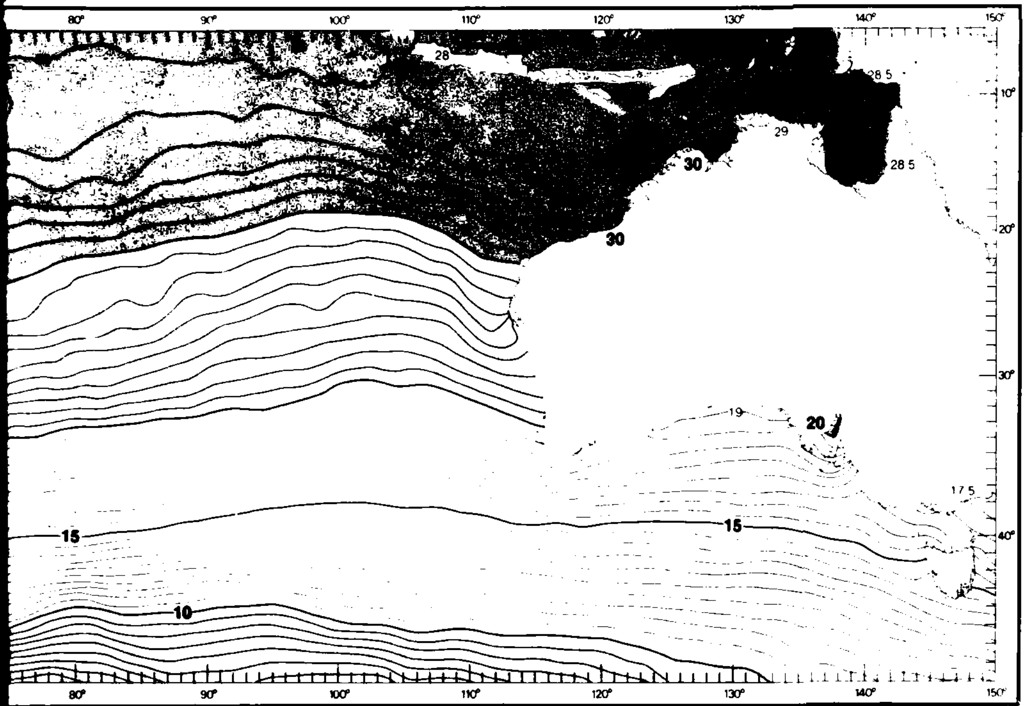
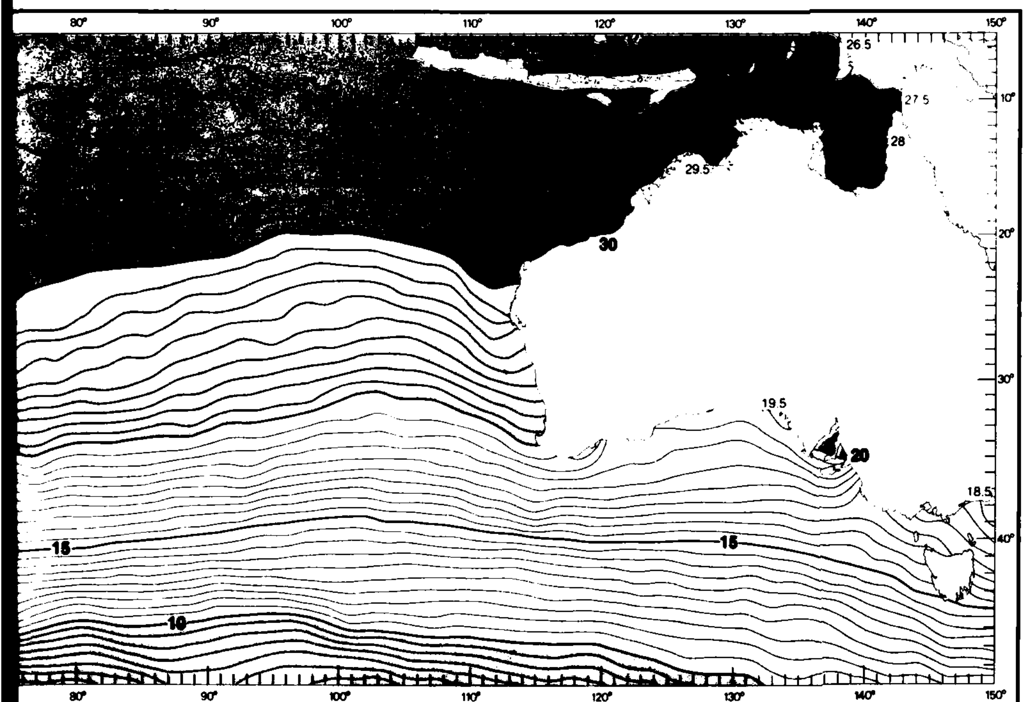


FIGURE 195. FEBRUARY SOUTH INDIAN OCEAN MEAN TEMPERATURES AT TH



N OCEAN MEAN TEMPERATURES AT THE SURFACE



OCEAN MEAN TEMPERATURES AT THE SURFACE

LEGEND

TEMPERATURE (°C.)

<0
0 - 5
5 - 10
10 - 15
15 - 20
20 - 25
25 - 30
>30

0.5°C CONTOUR INTERVAL

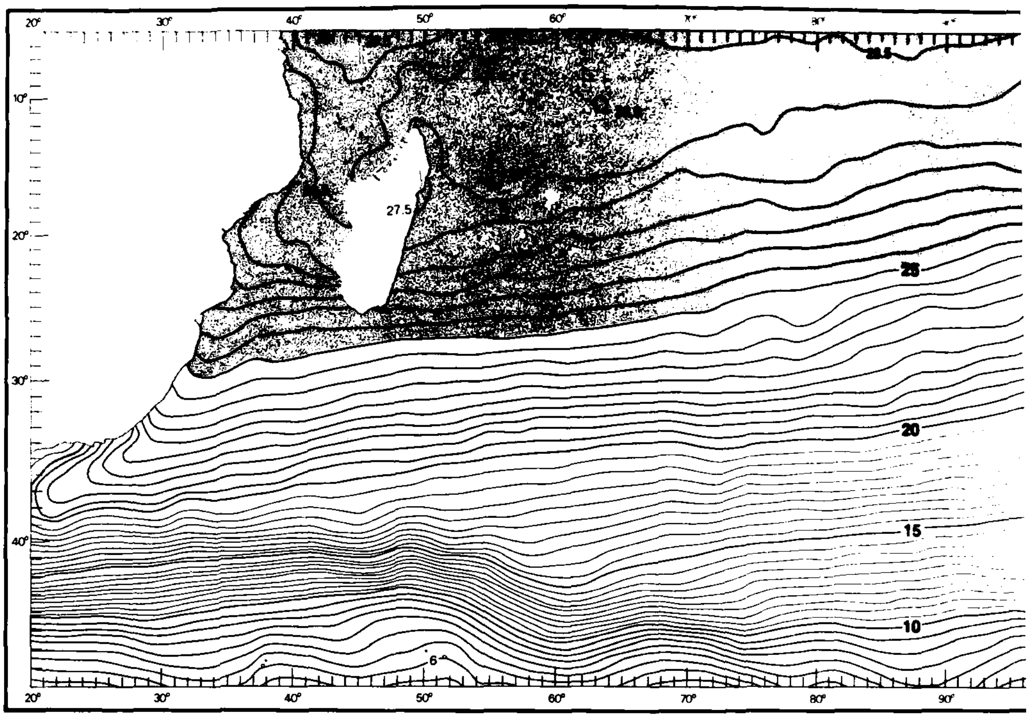


FIGURE 196. MARCH SOUTH INDIAN OCEAN MEAN TEMPERATU

TEMPERATURE CONVERSION TABLE							
(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

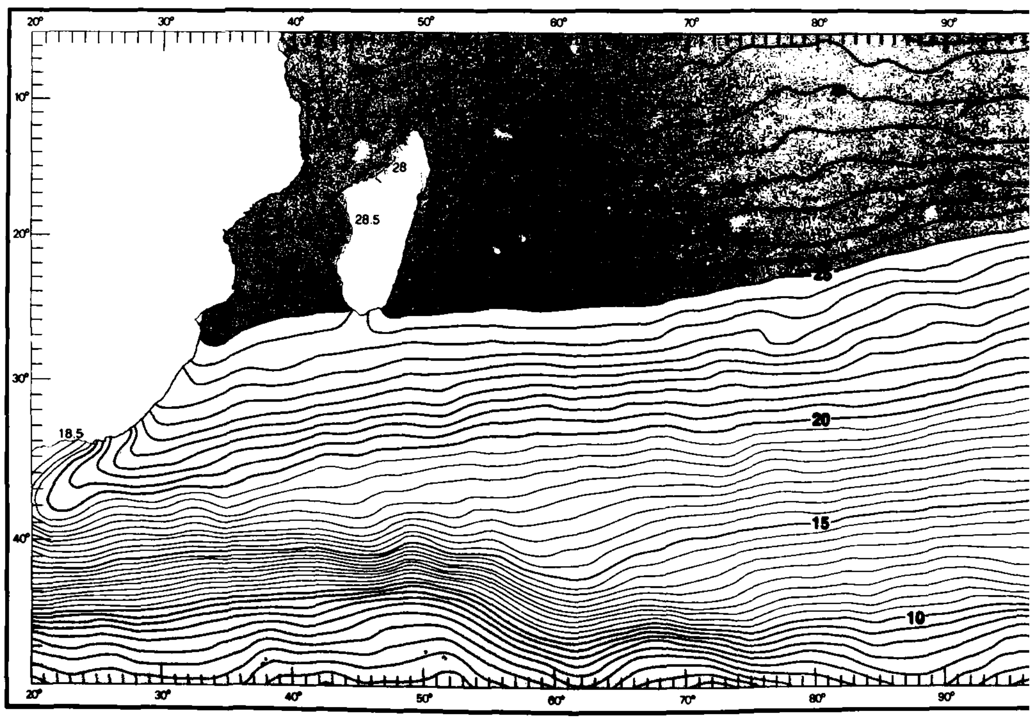


FIGURE 197. APRIL SOUTH INDIAN OCEAN MEAN TEMPERATU

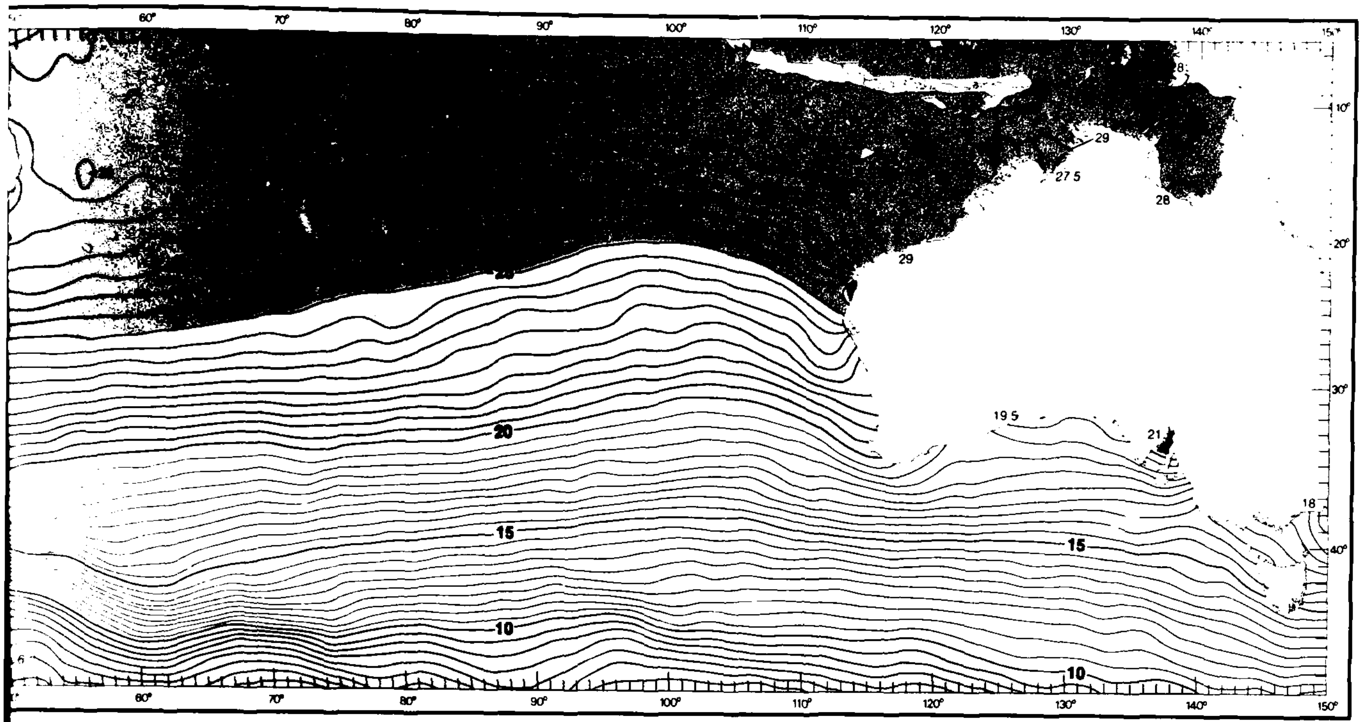


FIGURE 196. MARCH SOUTH INDIAN OCEAN MEAN TEMPERATURES AT THE SURFACE

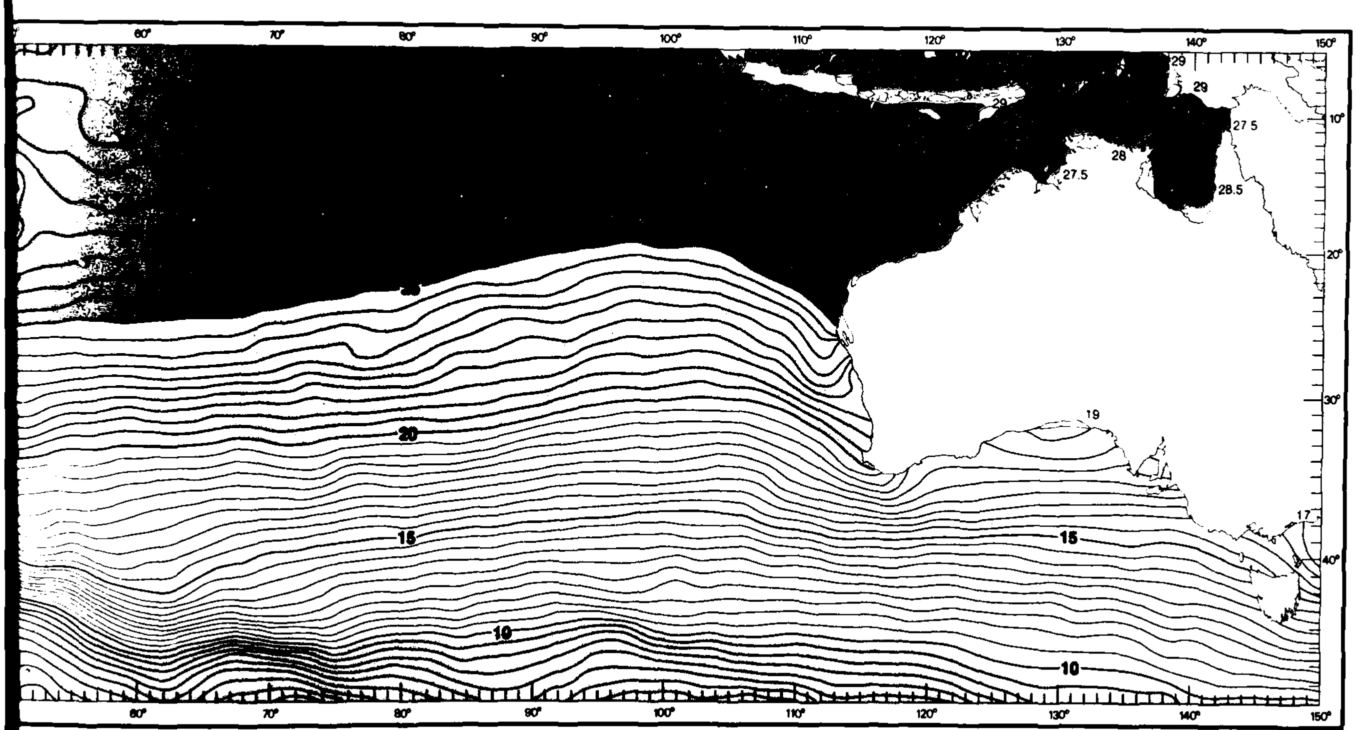


FIGURE 197. APRIL SOUTH INDIAN OCEAN MEAN TEMPERATURES AT THE SURFACE

LEGEND

TEMPERATURE (°C.)

- <0
- 0 - 5
- 5 - 10
- 10 - 15
- 15 - 20
- 20 - 25
- 25 - 30
- >30

0.5°C CONTOUR INTERVAL

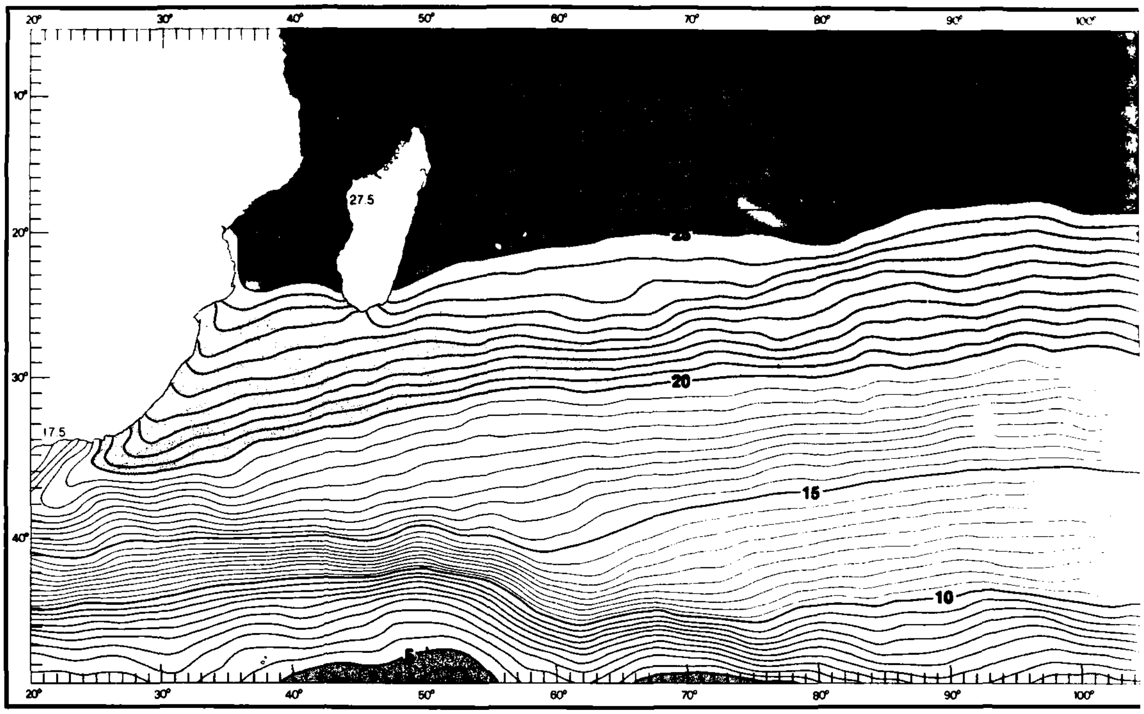


FIGURE 198. MAY SOUTH INDIAN OCEAN MEAN TEMPERATURES AT THE

TEMPERATURE CONVERSION TABLE							
(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

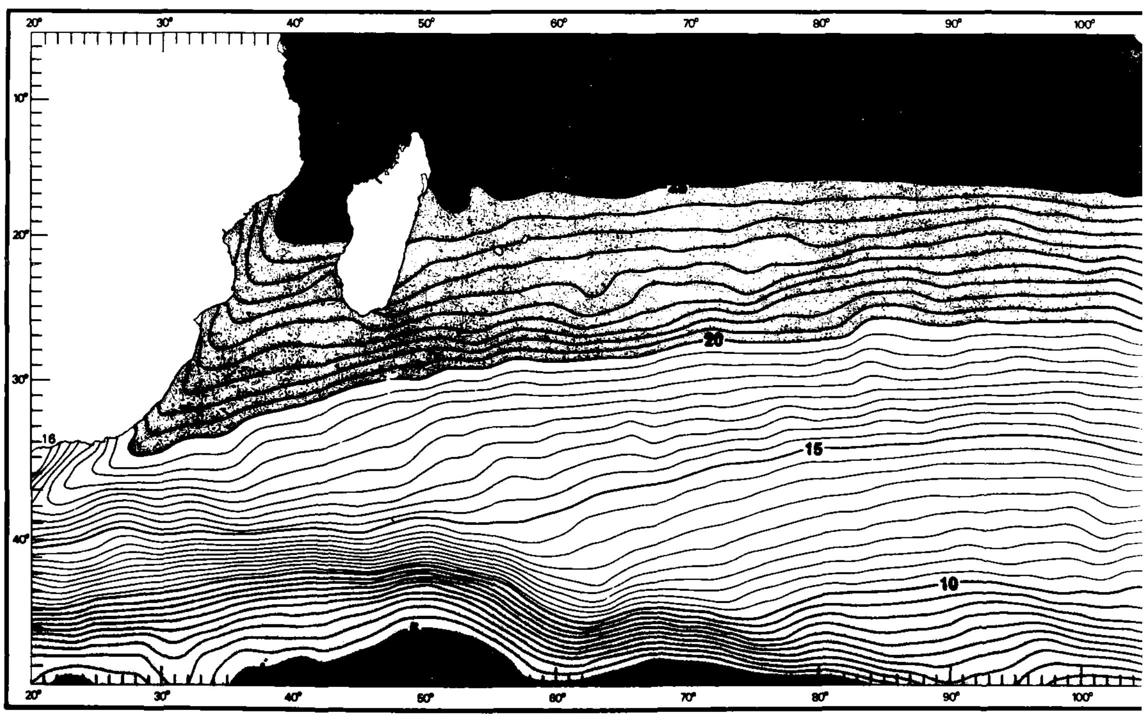
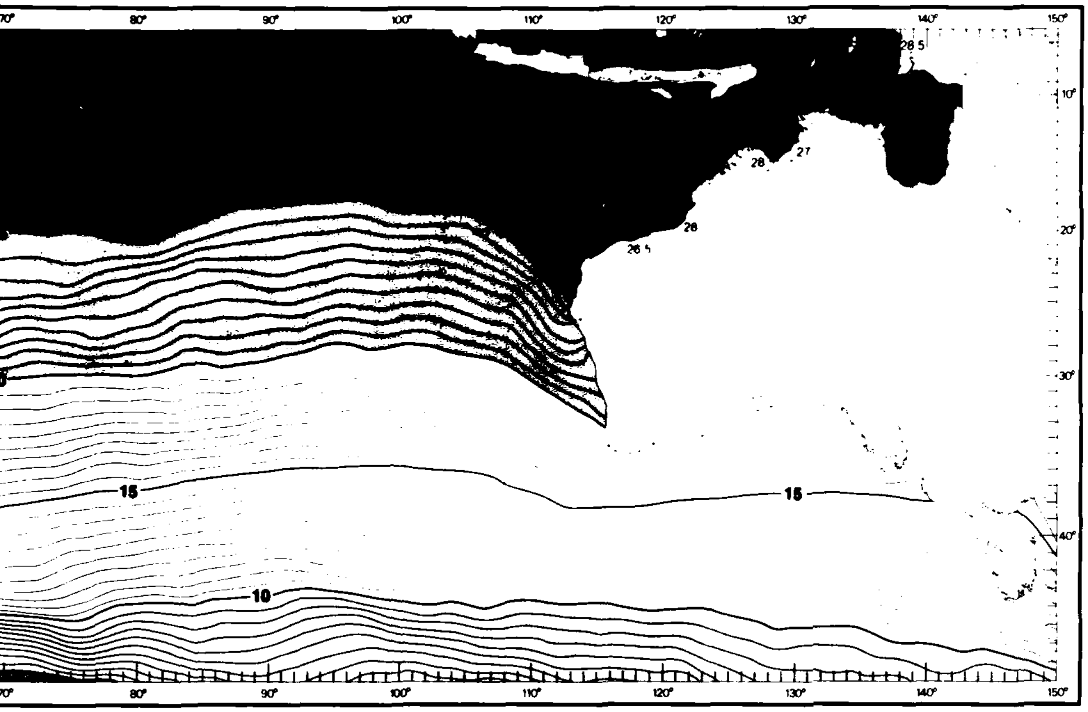
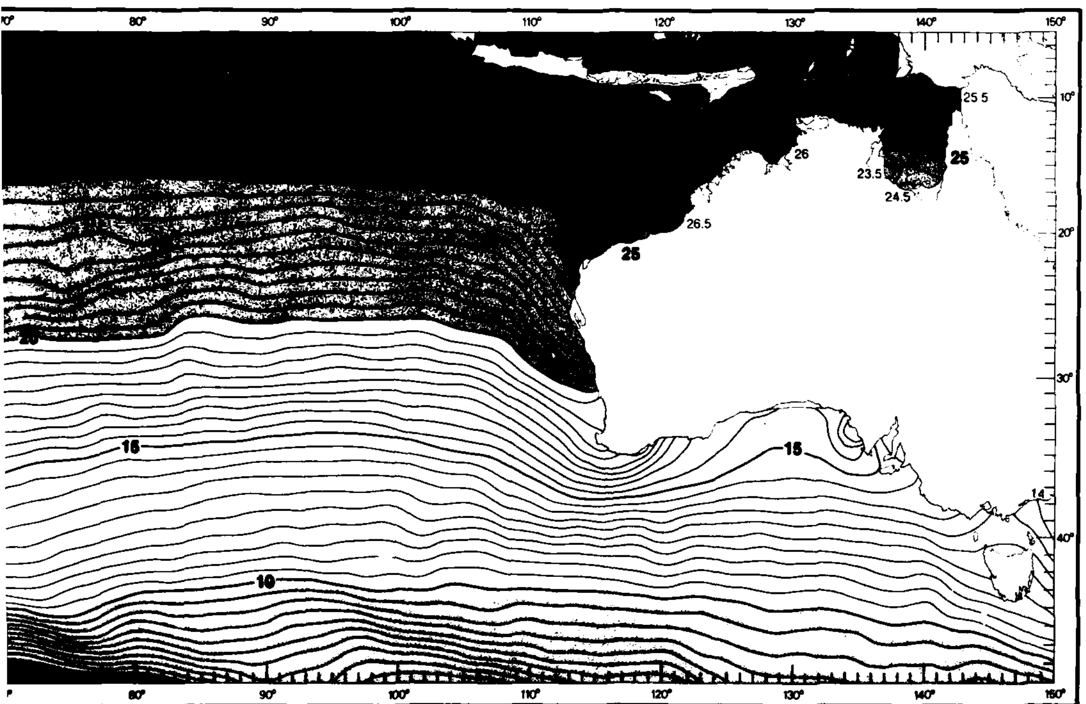


FIGURE 199. JUNE SOUTH INDIAN OCEAN MEAN TEMPERATURES AT THE



INDIAN OCEAN MEAN TEMPERATURES AT THE SURFACE



INDIAN OCEAN MEAN TEMPERATURES AT THE SURFACE

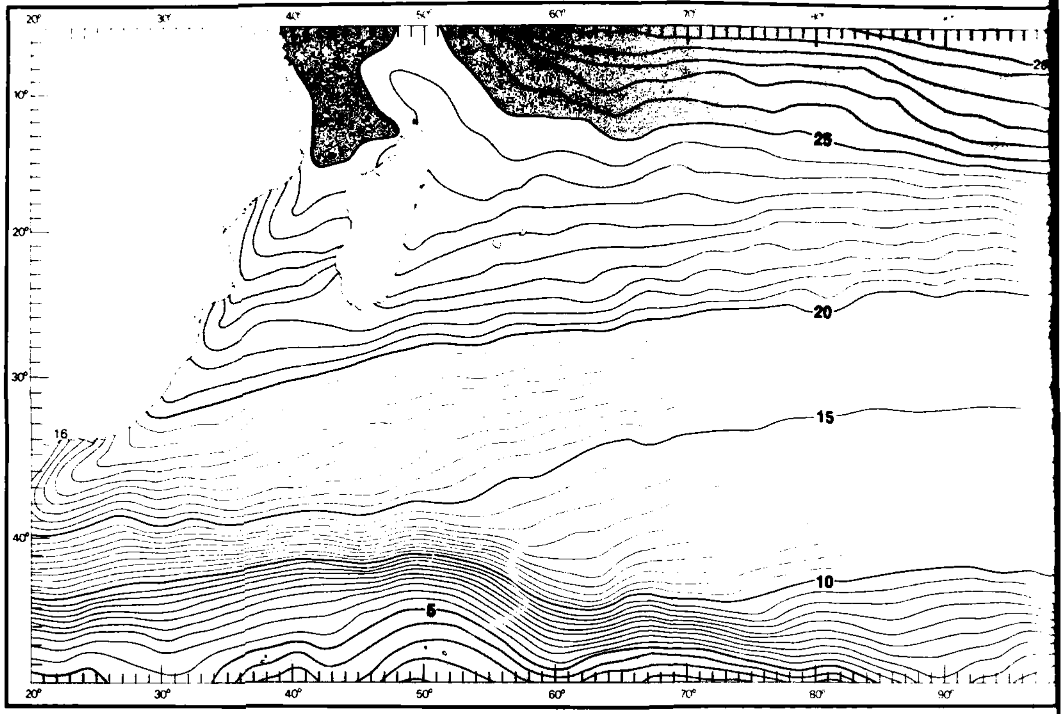
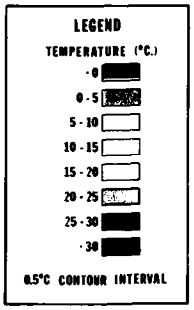


FIGURE 200. JULY SOUTH INDIAN OCEAN MEAN TEMPERATURES



TEMPERATURE CONVERSION TABLE							
(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

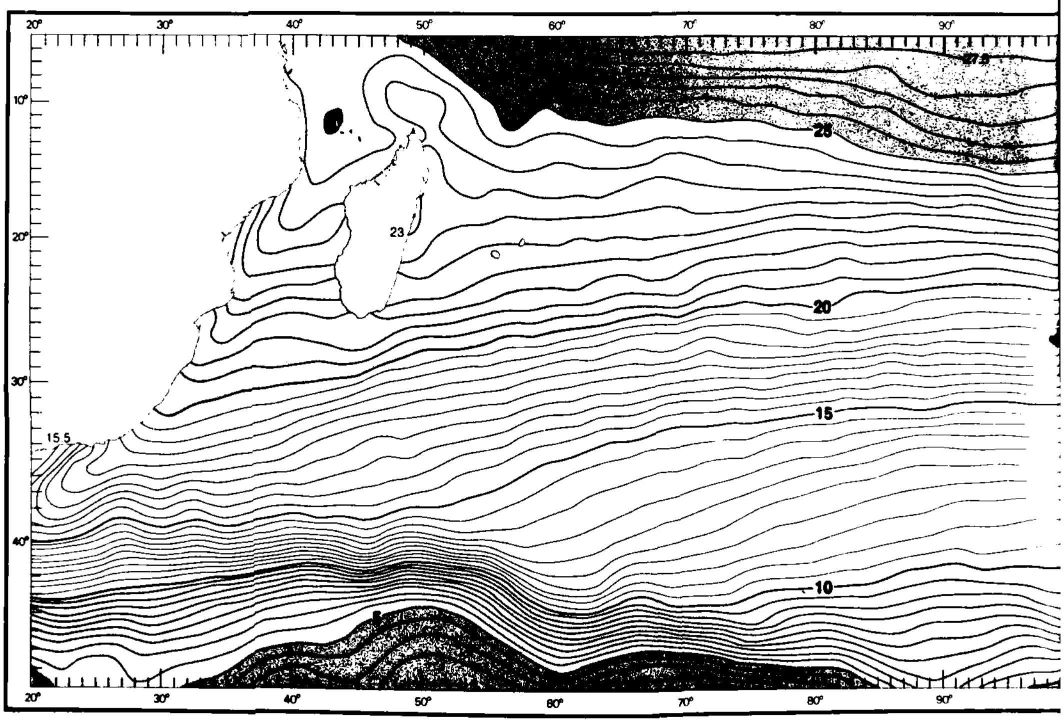
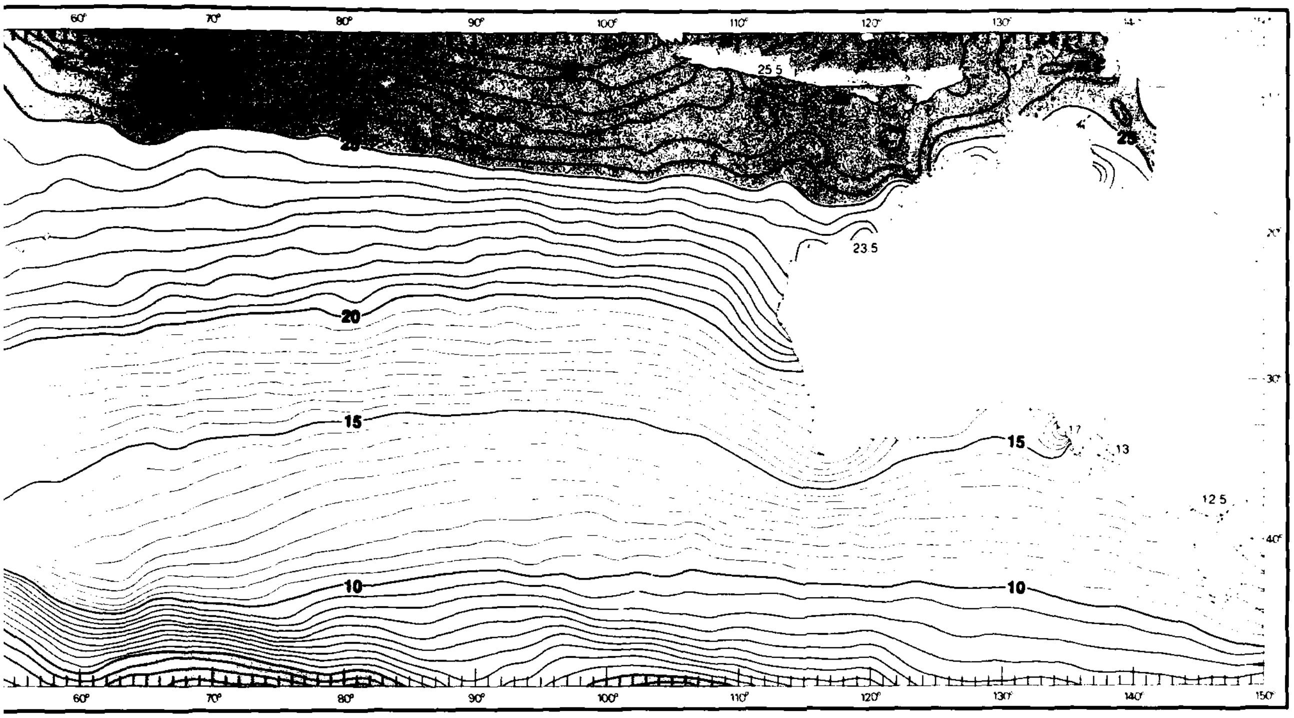
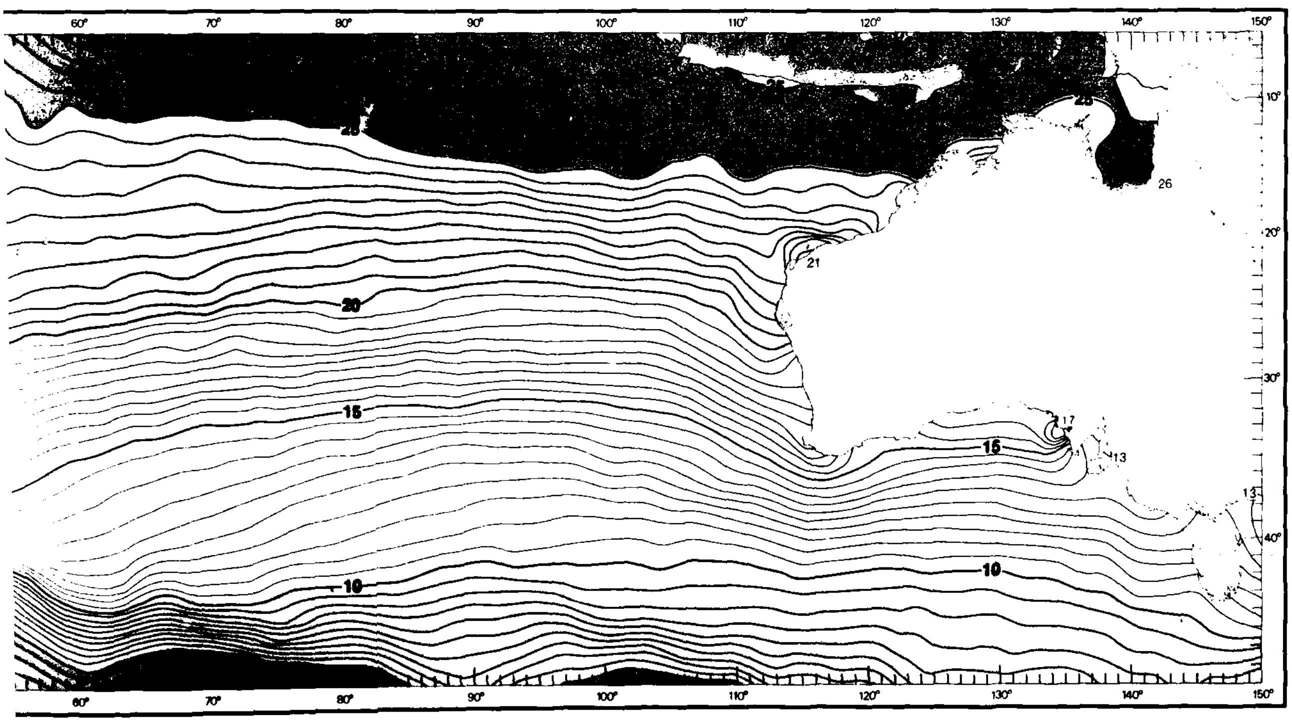


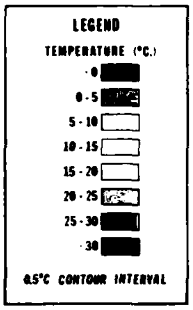
FIGURE 201. AUGUST SOUTH INDIAN OCEAN MEAN TEMPERATURES



ɪURE 200. JULY SOUTH INDIAN OCEAN MEAN TEMPERATURES AT THE SURFACE



201. AUGUST SOUTH INDIAN OCEAN MEAN TEMPERATURES AT THE SURFACE



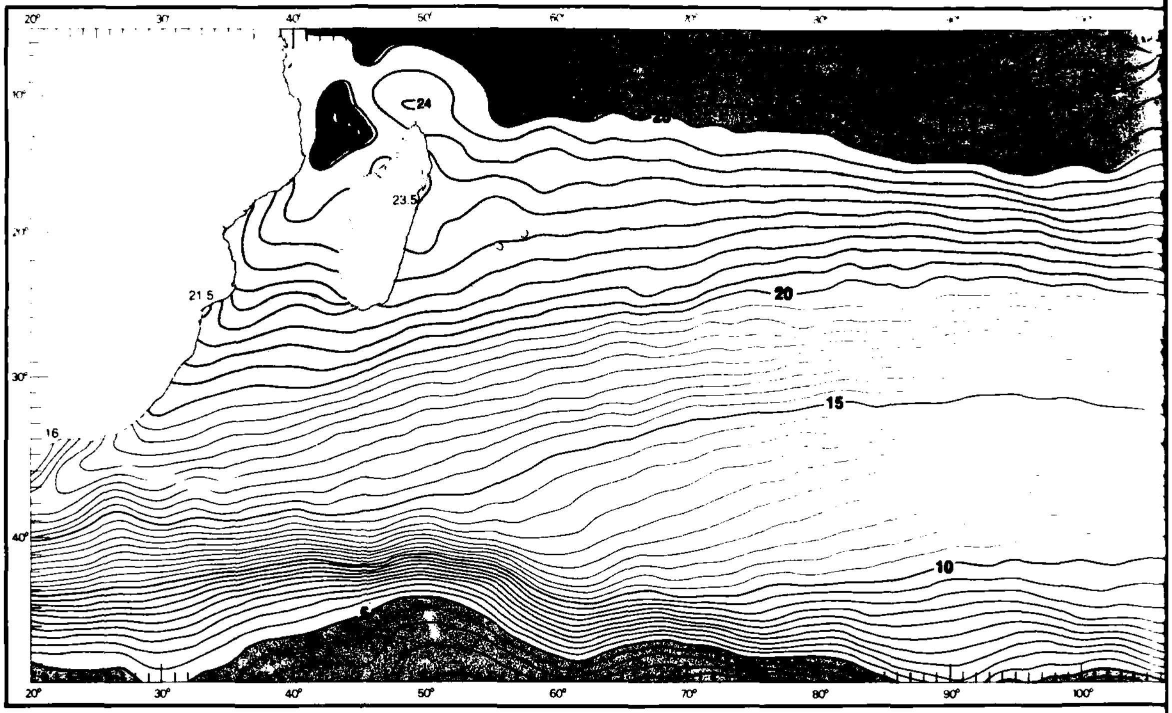


FIGURE 202. SEPTEMBER SOUTH INDIAN OCEAN MEAN TEMPERATURES A

TEMPERATURE CONVERSION TABLE							
(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

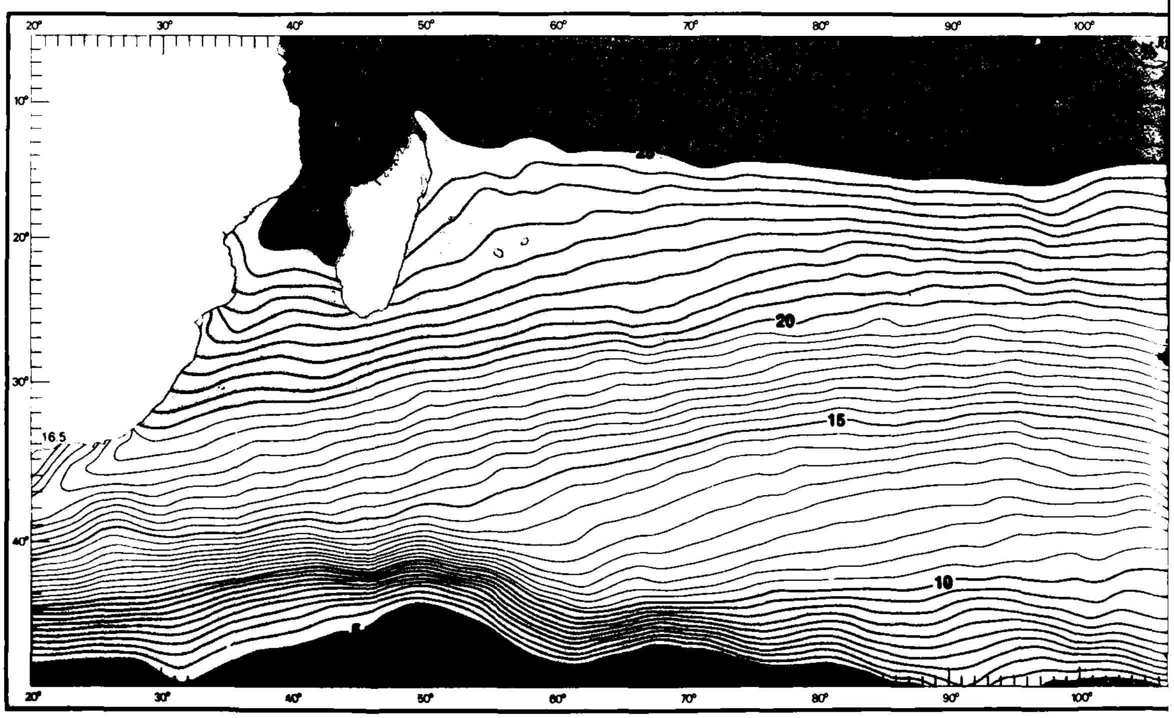
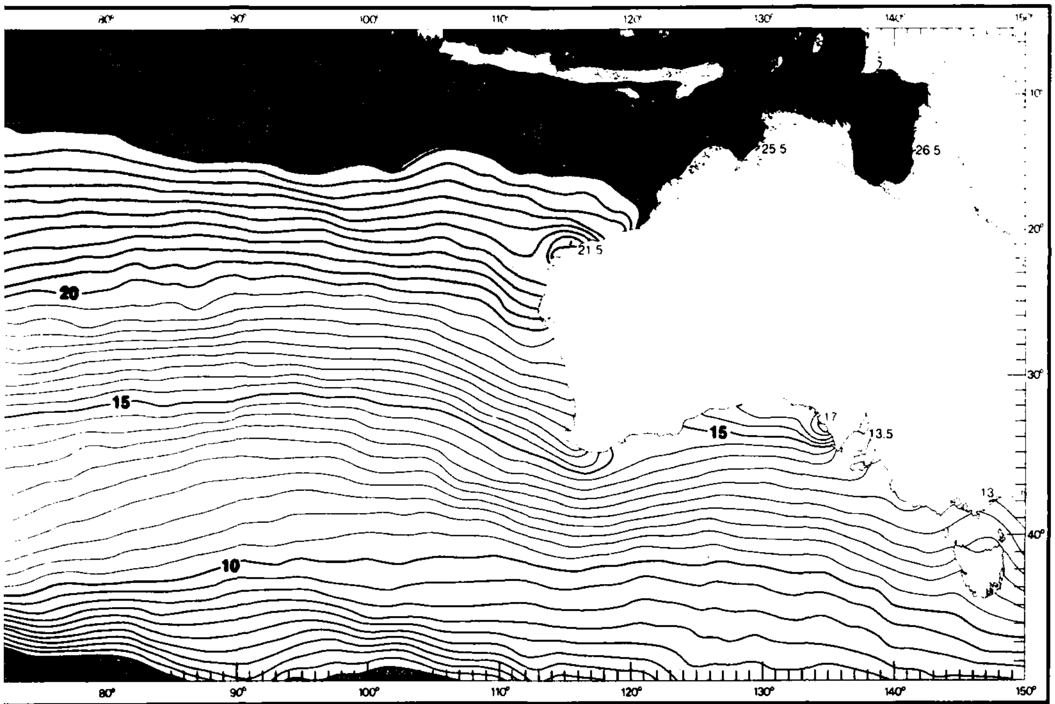
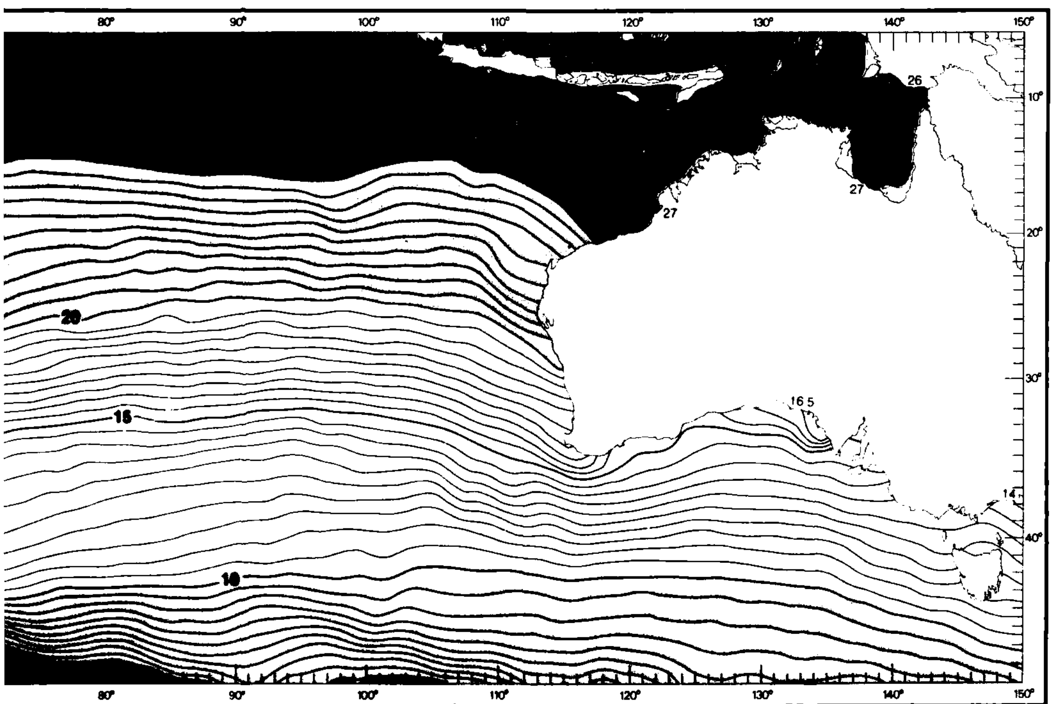


FIGURE 203. OCTOBER SOUTH INDIAN OCEAN MEAN TEMPERATURES AT



)UTH INDIAN OCEAN MEAN TEMPERATURES AT THE SURFACE



)UTH INDIAN OCEAN MEAN TEMPERATURES AT THE SURFACE

LEGEND

TEMPERATURE (°C.)

- ·0
- 0 - 5
- 5 - 10
- 10 - 15
- 15 - 20
- 20 - 25
- 25 - 30
- ·30

0.5°C CONTOUR INTERVAL

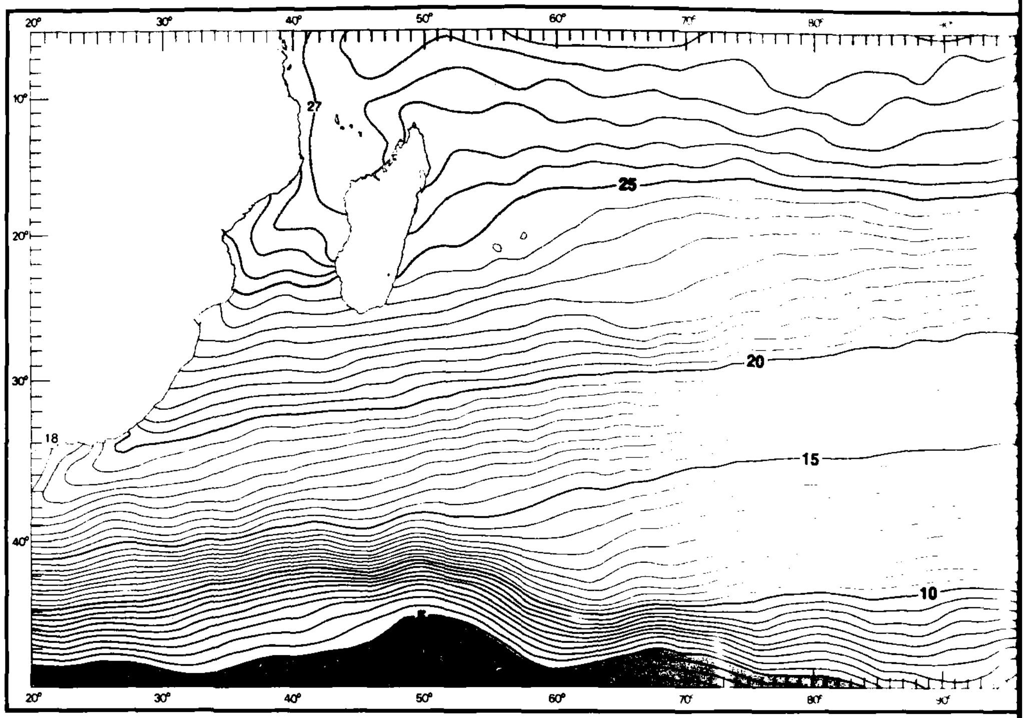


FIGURE 204. NOVEMBER SOUTH INDIAN OCEAN MEAN TEM

TEMPERATURE CONVERSION TABLE							
(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

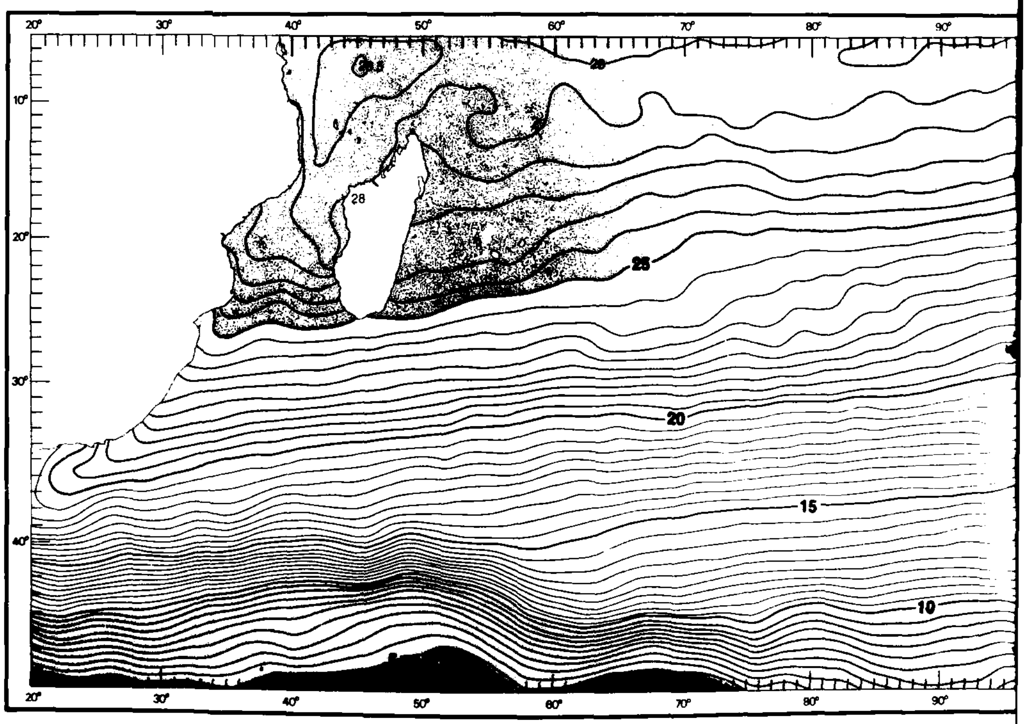


FIGURE 205. DECEMBER SOUTH INDIAN OCEAN MEAN TEMPE

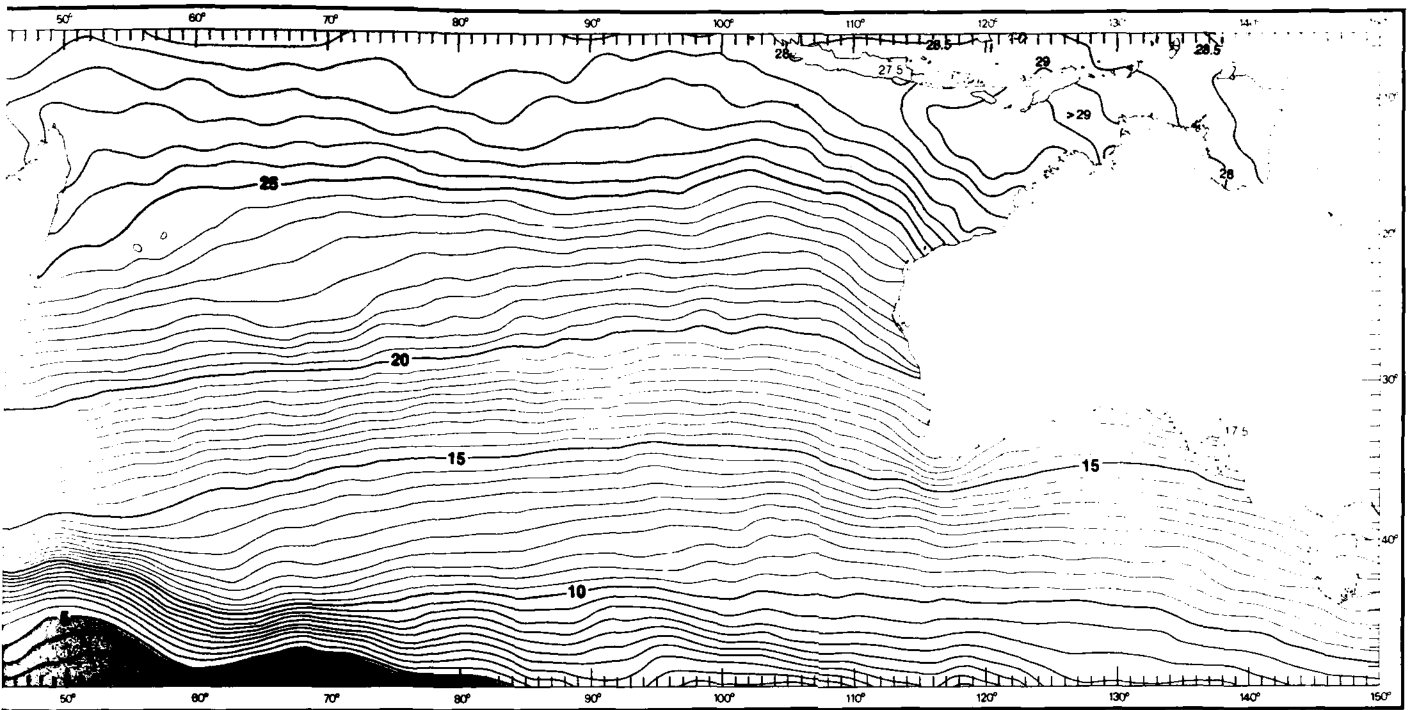


FIGURE 204. NOVEMBER SOUTH INDIAN OCEAN MEAN TEMPERATURES AT THE SURFACE

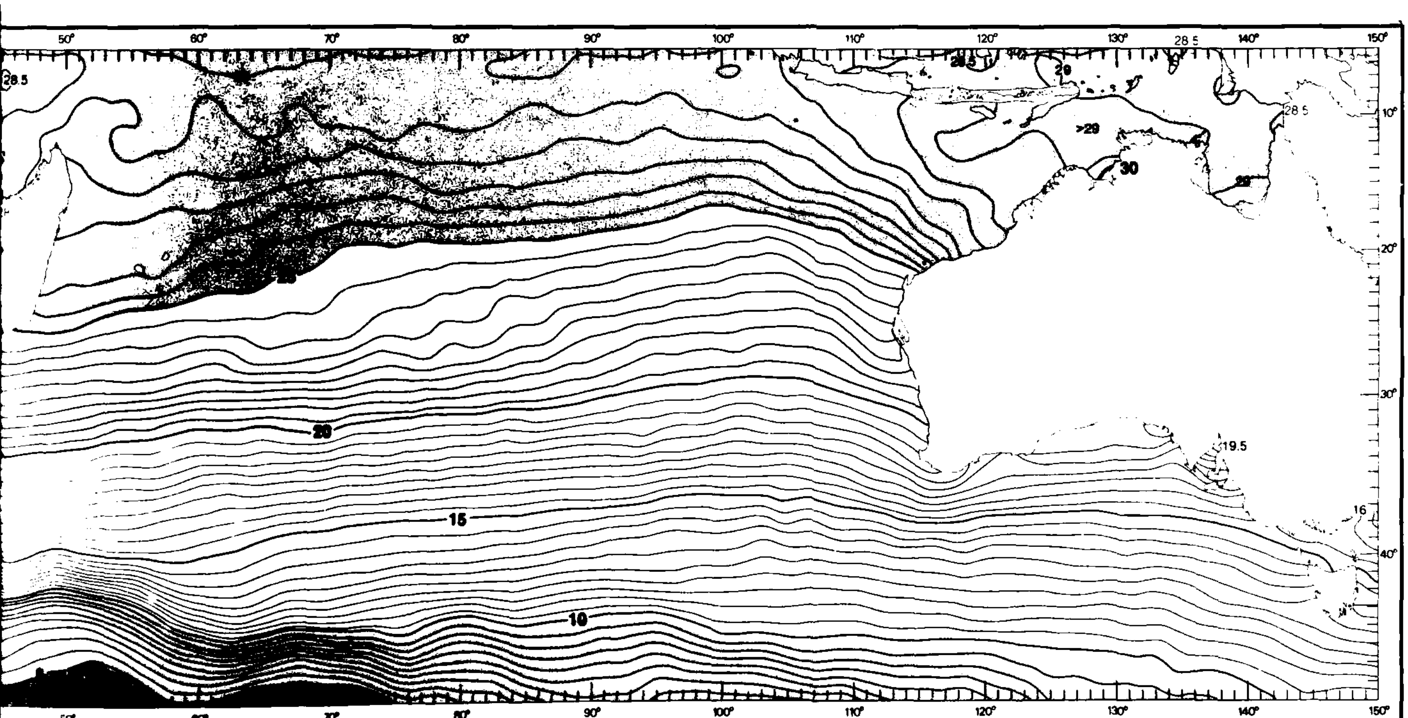


FIGURE 205. DECEMBER SOUTH INDIAN OCEAN MEAN TEMPERATURES AT THE SURFACE

LEGEND

TEMPERATURE (°C.)

- ·0
- 0 - 5
- 5 - 10
- 10 - 15
- 15 - 20
- 20 - 25
- 25 - 30
- ·30

0.5°C CONTOUR INTERVAL

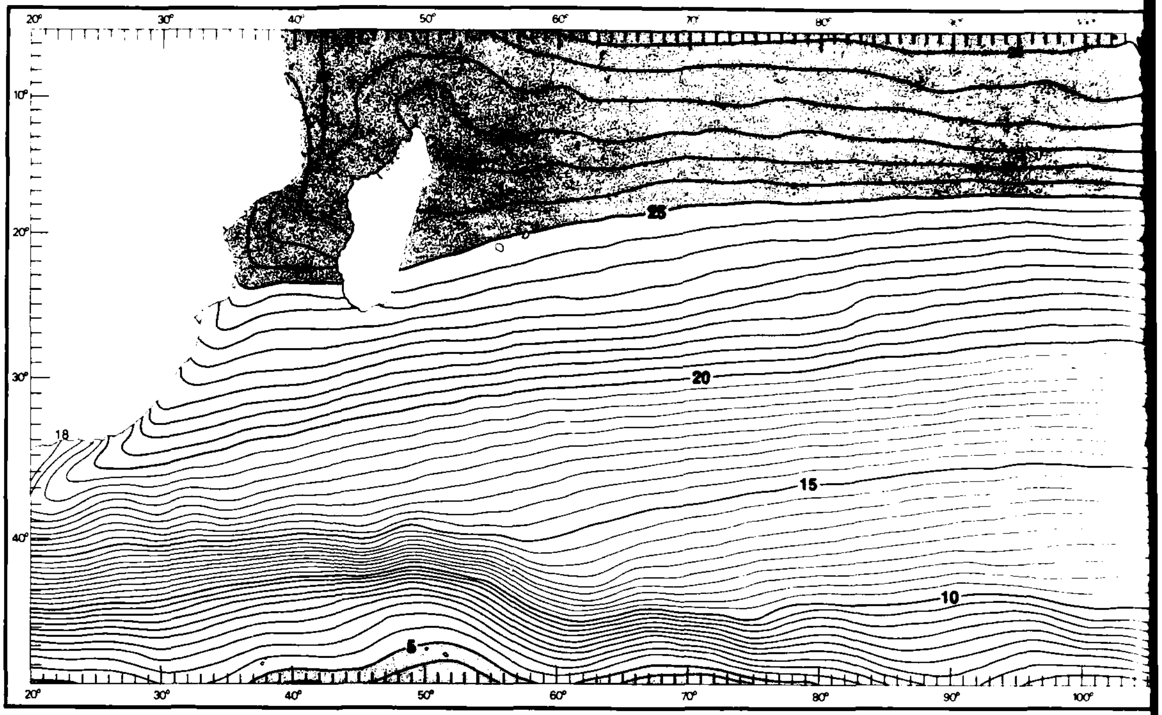


FIGURE 206. SOUTH INDIAN OCEAN ANNUAL MEAN TEMPERATURES AT T

TEMPERATURE CONVERSION TABLE							
(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)	(°C.)	(°F.)
-2	28.4	7	44.6	16	60.8	25	77.0
-1	30.2	8	46.4	17	62.6	26	78.8
0	32.0	9	48.2	18	64.4	27	80.6
1	33.8	10	50.0	19	66.2	28	82.4
2	35.6	11	51.8	20	68.0	29	84.2
3	37.4	12	53.6	21	69.8	30	86.0
4	39.2	13	55.4	22	71.6	31	87.8
5	41.0	14	57.2	23	73.4	32	89.6
6	42.8	15	59.0	24	75.2	33	91.4

TEMPERATURE DIFFERENCE CONVERSION			
°C	°F	°C	°F
1	1.8	11	19.8
2	3.6	12	21.6
3	5.4	13	23.4
4	7.2	14	25.2
5	9.0	15	27.0
6	10.8	16	28.8
7	12.6	17	30.6
8	14.4	18	32.4
9	16.2	19	34.2
10	18.0	20	35.0

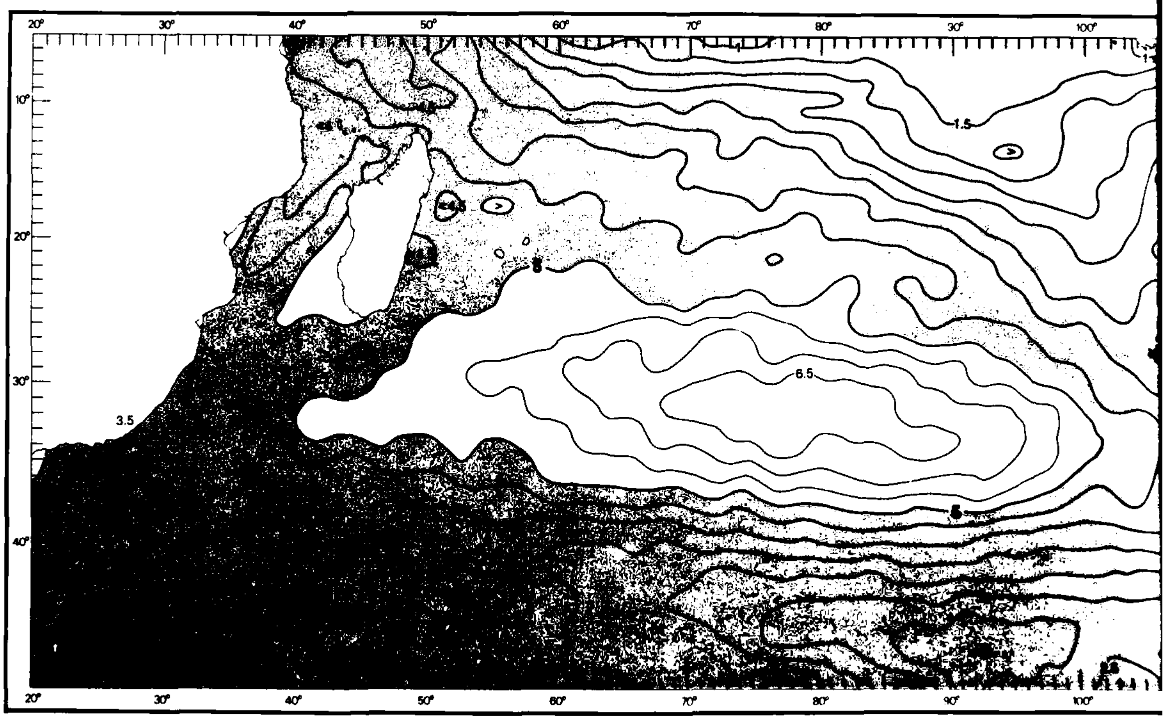
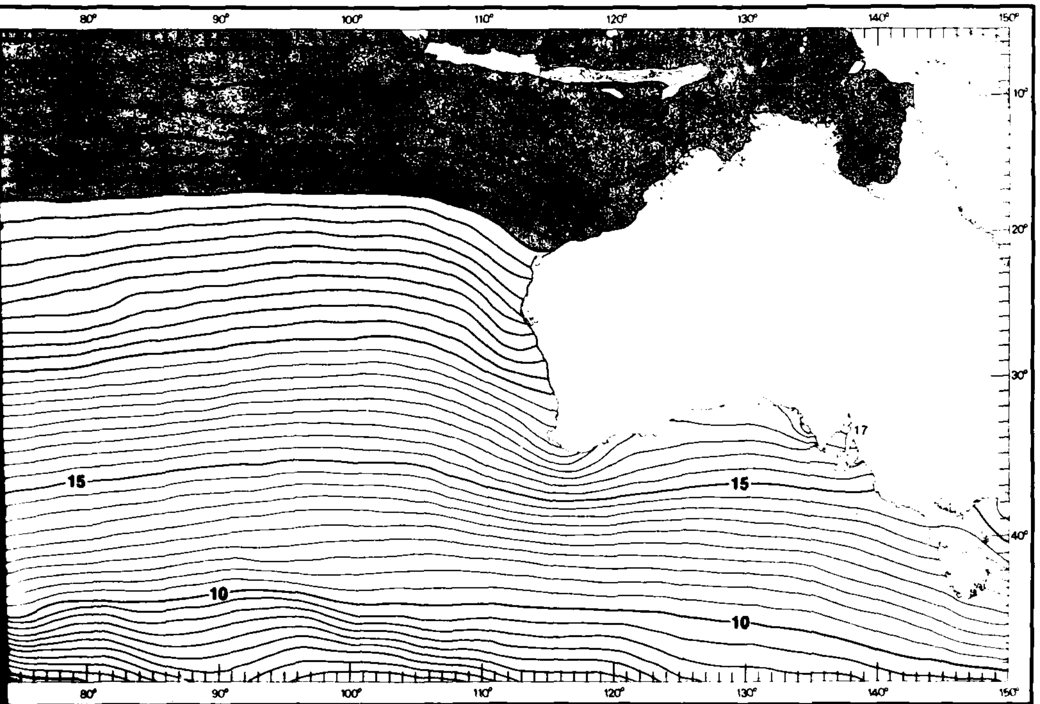
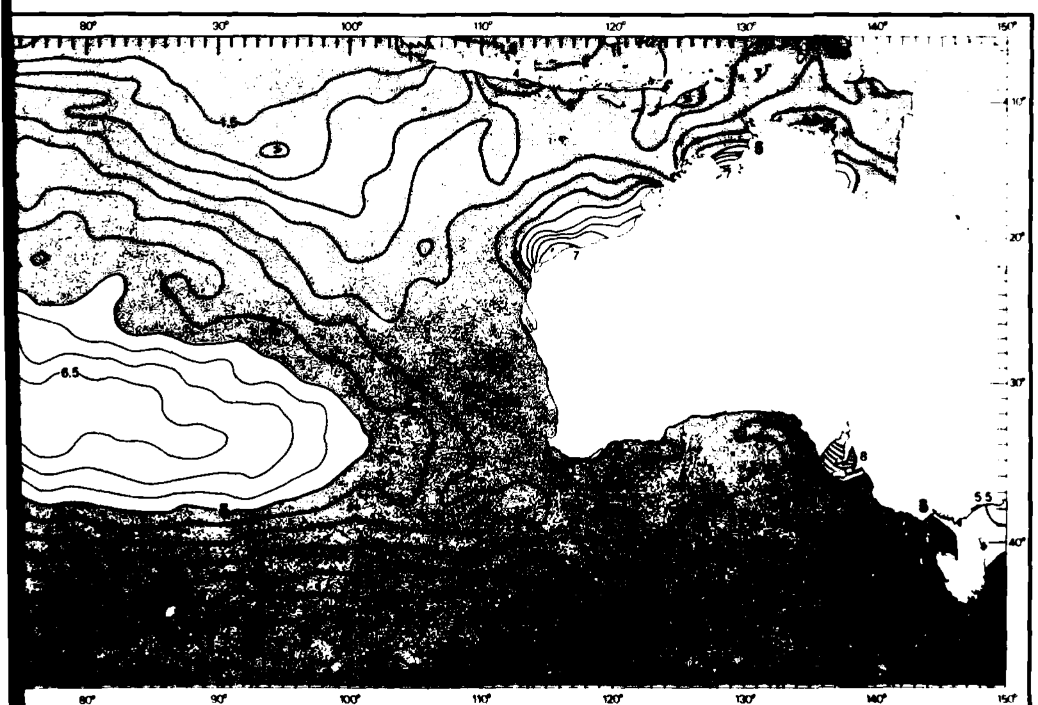


FIGURE 207. SOUTH INDIAN OCEAN ANNUAL TEMPERATURE RANGE AT T



EAN ANNUAL MEAN TEMPERATURES AT THE SURFACE



AN ANNUAL TEMPERATURE RANGE AT THE SURFACE

ANNUAL CYCLE TEMPERATURE CURVES

NOTE: CURVES AT 0, 30, 60, 90, 120, 150 METERS

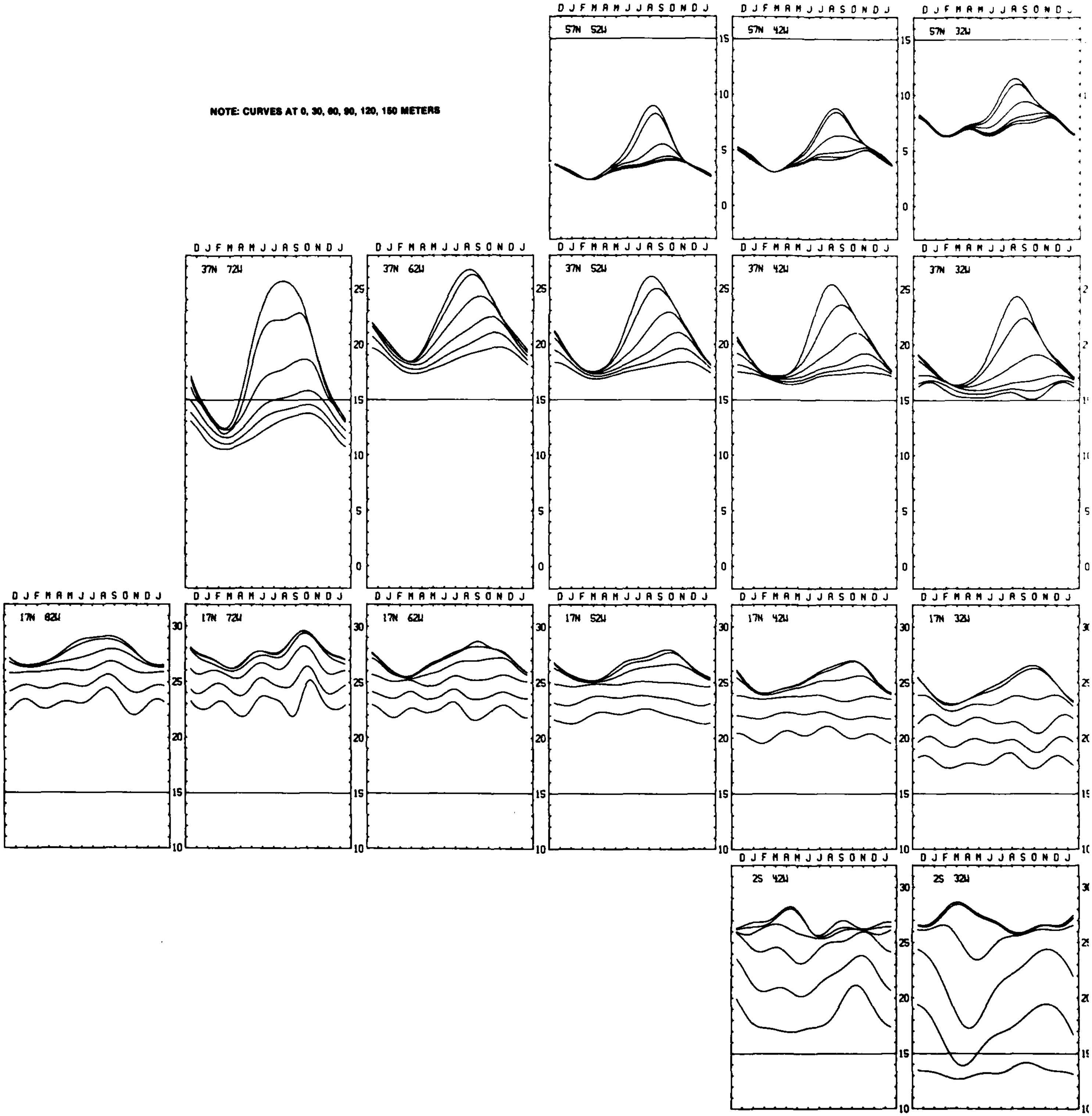
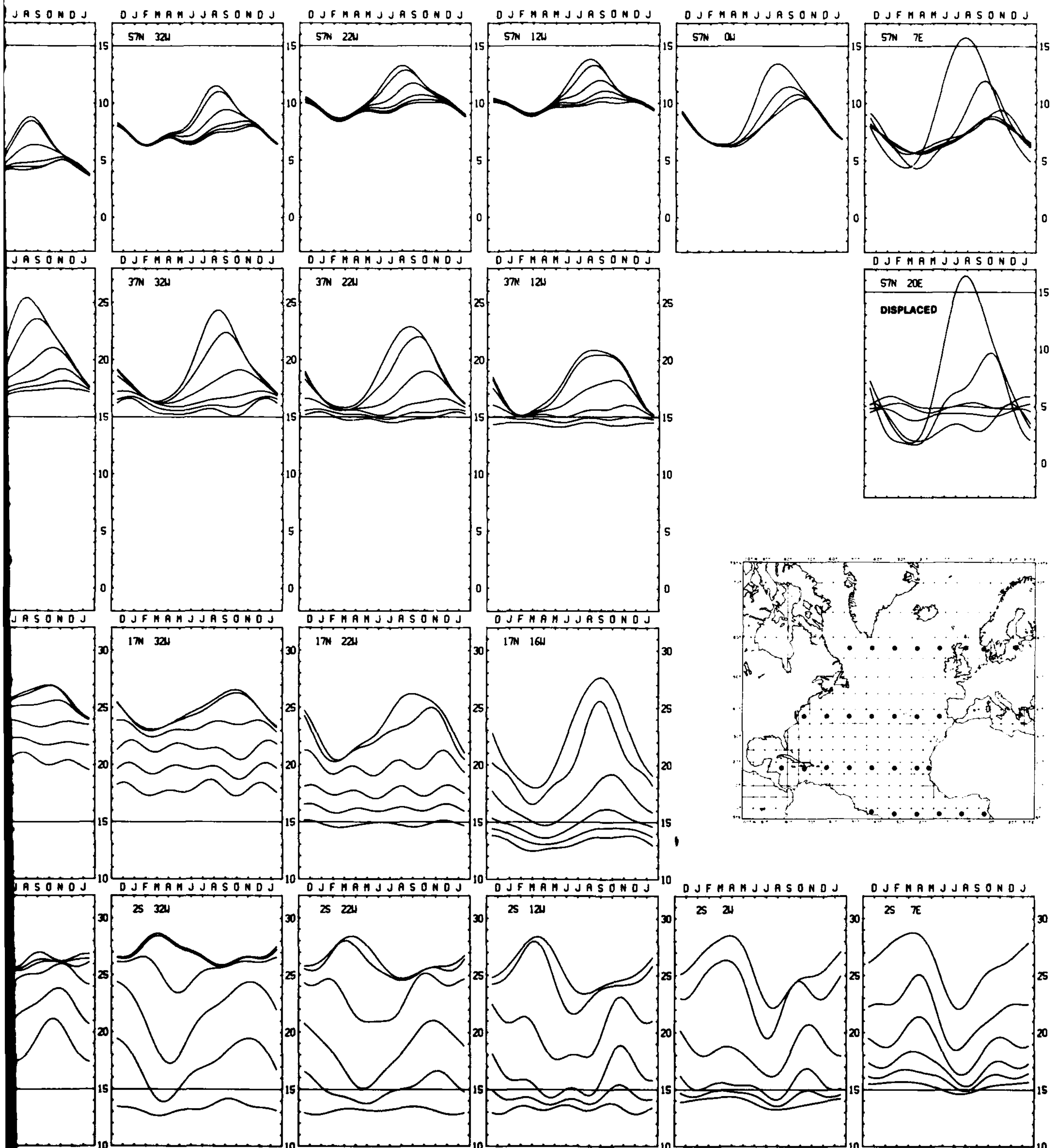


FIGURE 208. ANNUAL CYCLE TEMPERATURE CURVES — ATLANTIC OCEA

1



ERATURE CURVES — ATLANTIC OCEAN 2°S, 17°N, 37°N, 57°N

NOTE: CURVES AT 0, 30, 60, 90, 120, 150 METERS

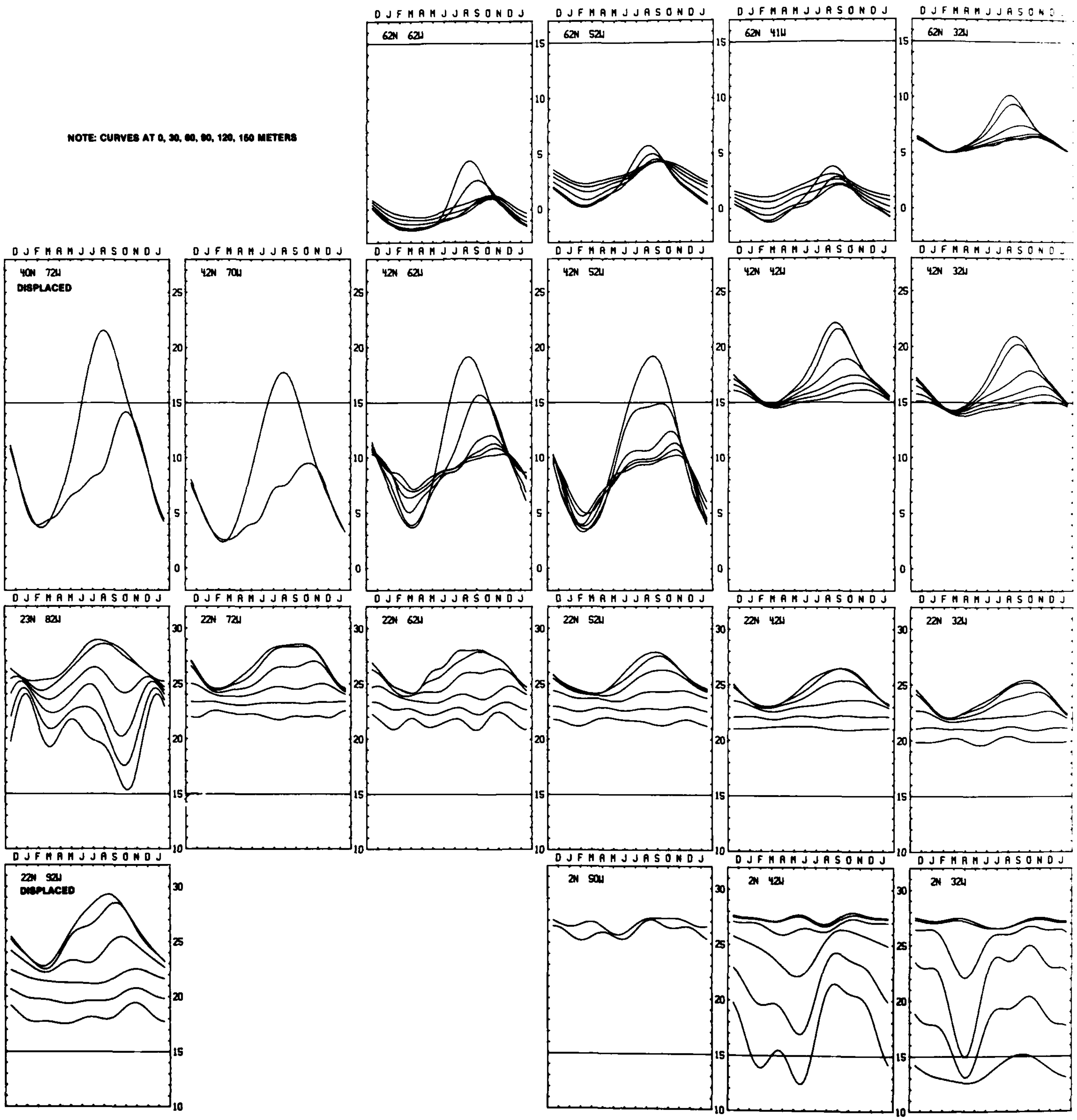
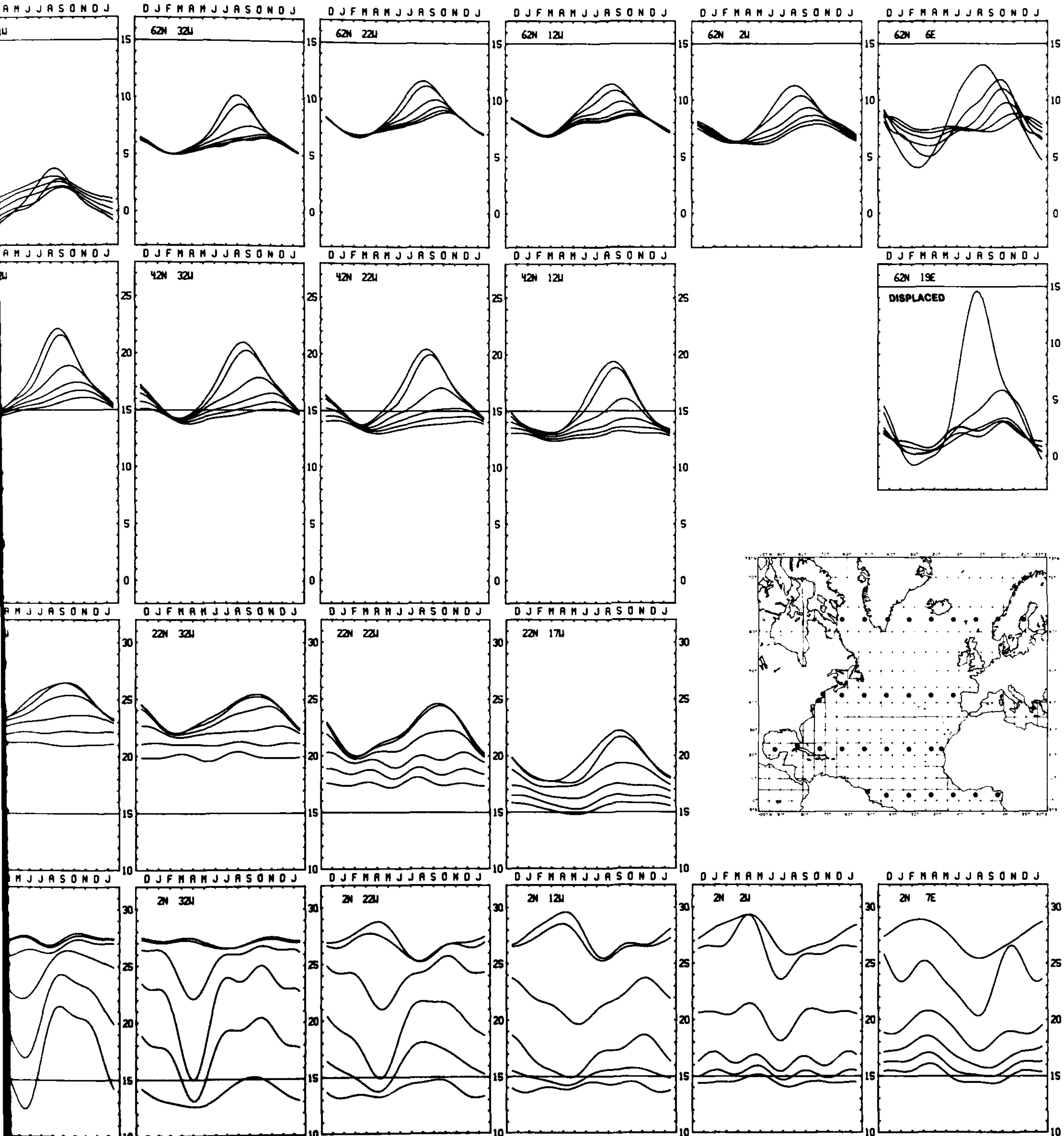


FIGURE 209. ANNUAL CYCLE TEMPERATURE CURVES — ATLANTIC OCE



EMPERATURE CURVES — ATLANTIC OCEAN 2°N, 22°N, 42°N, 62°N

NOTE: CURVES AT 0, 30, 60, 90, 120, 150 METERS

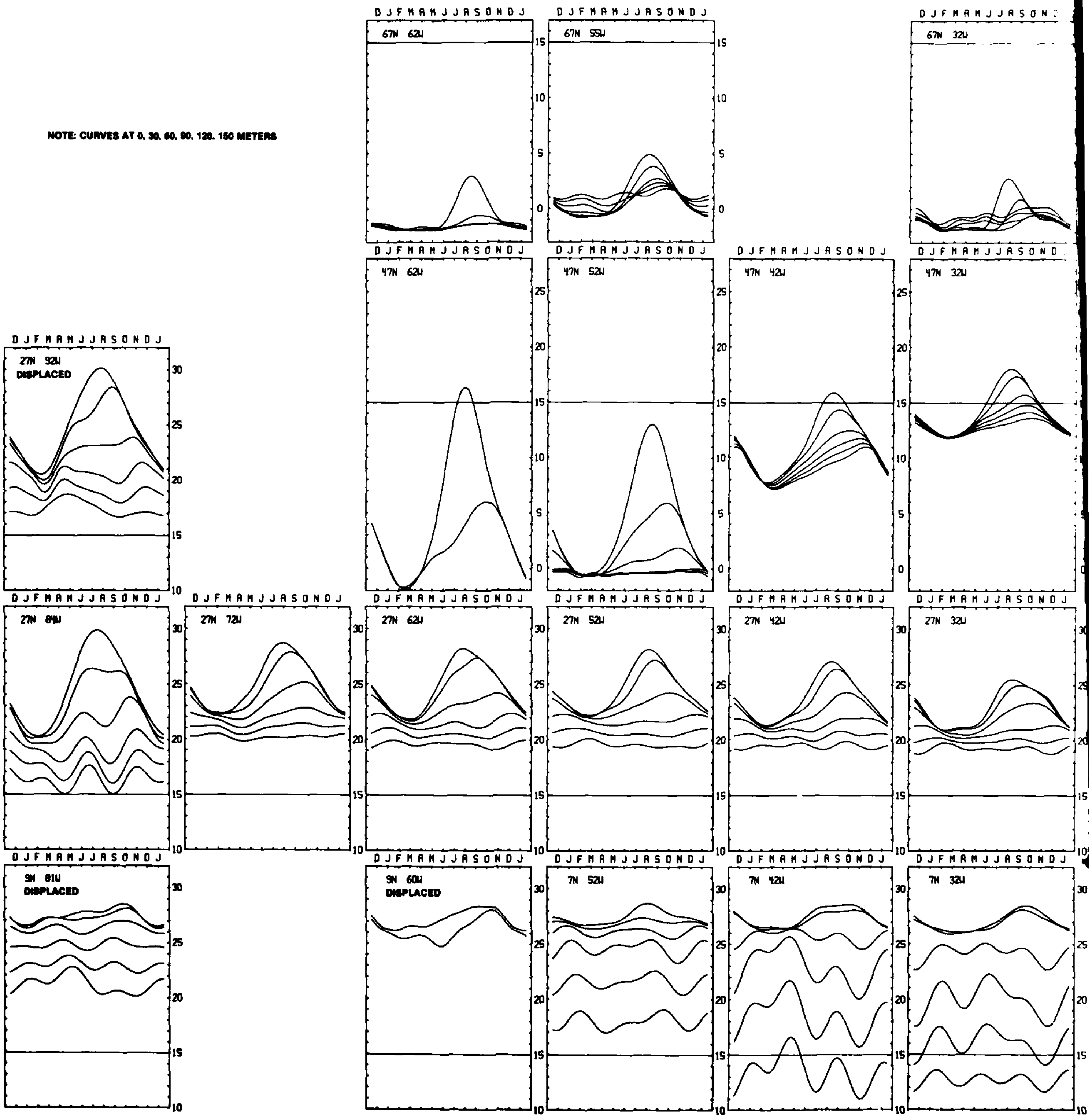
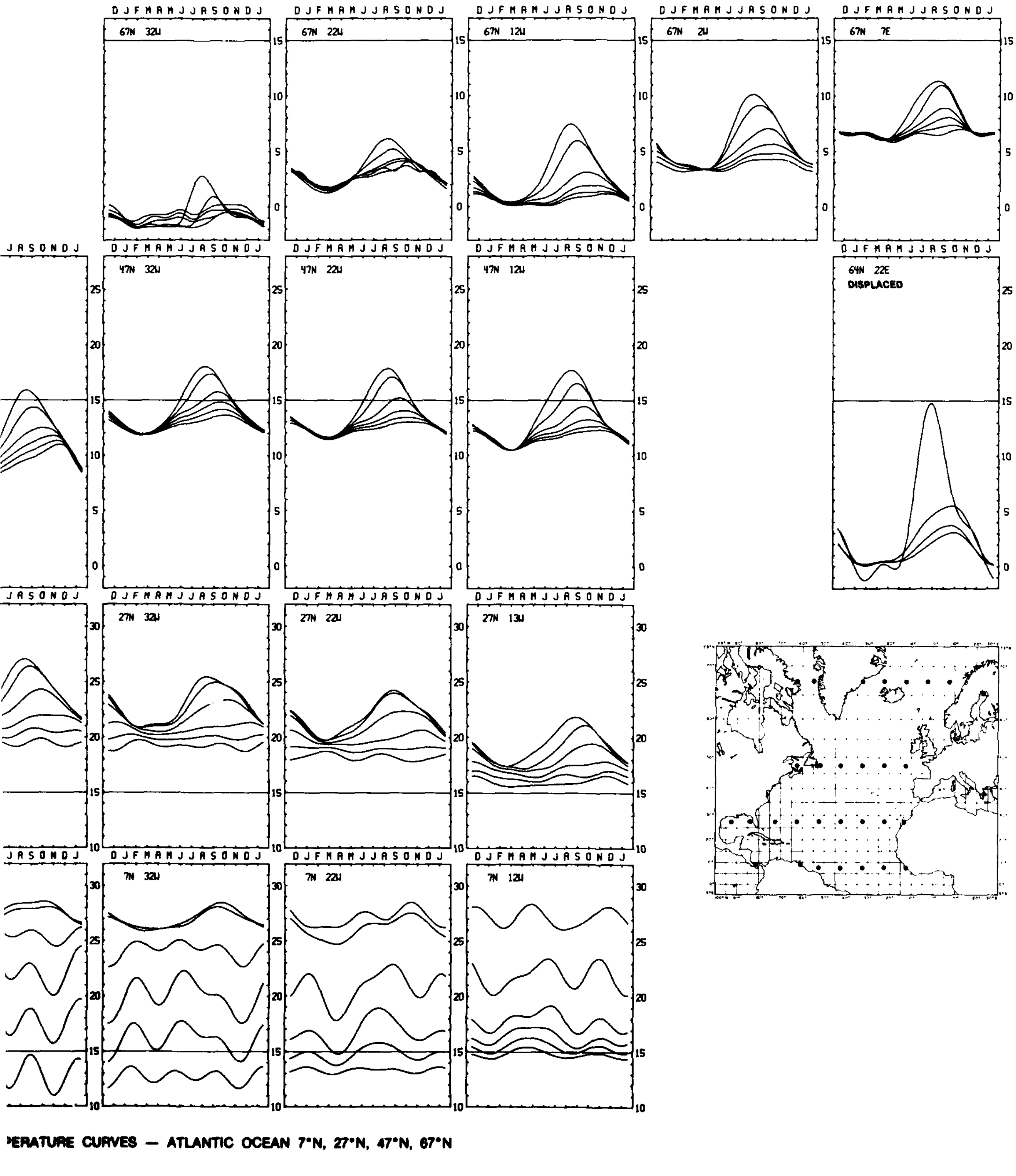


FIGURE 210. ANNUAL CYCLE TEMPERATURE CURVES — ATLANTIC OCEA



ERATURE CURVES — ATLANTIC OCEAN 7°N, 27°N, 47°N, 67°N

NOTE: CURVES AT 0. 30. 60. 90. 120. 150 METERS

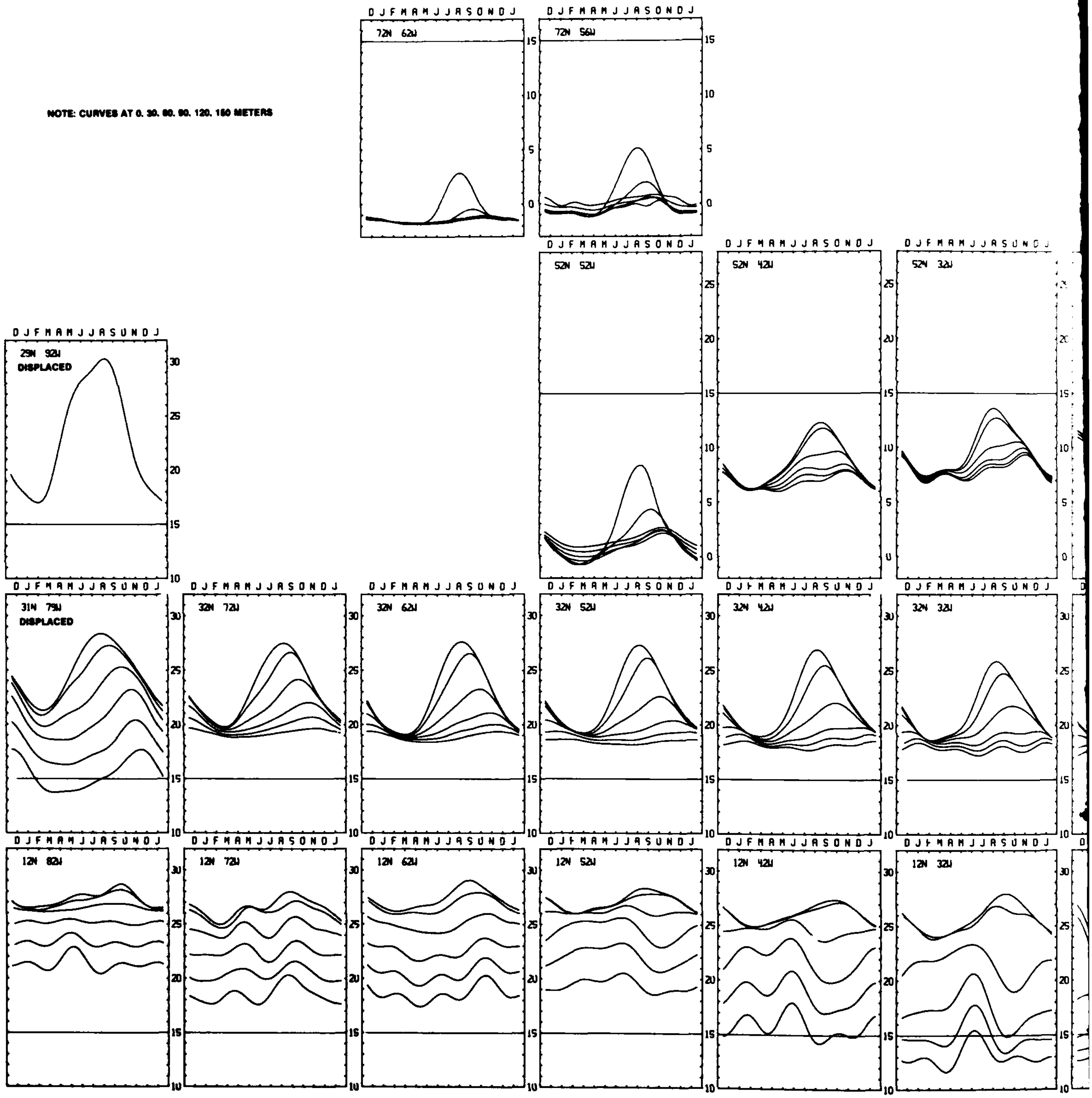
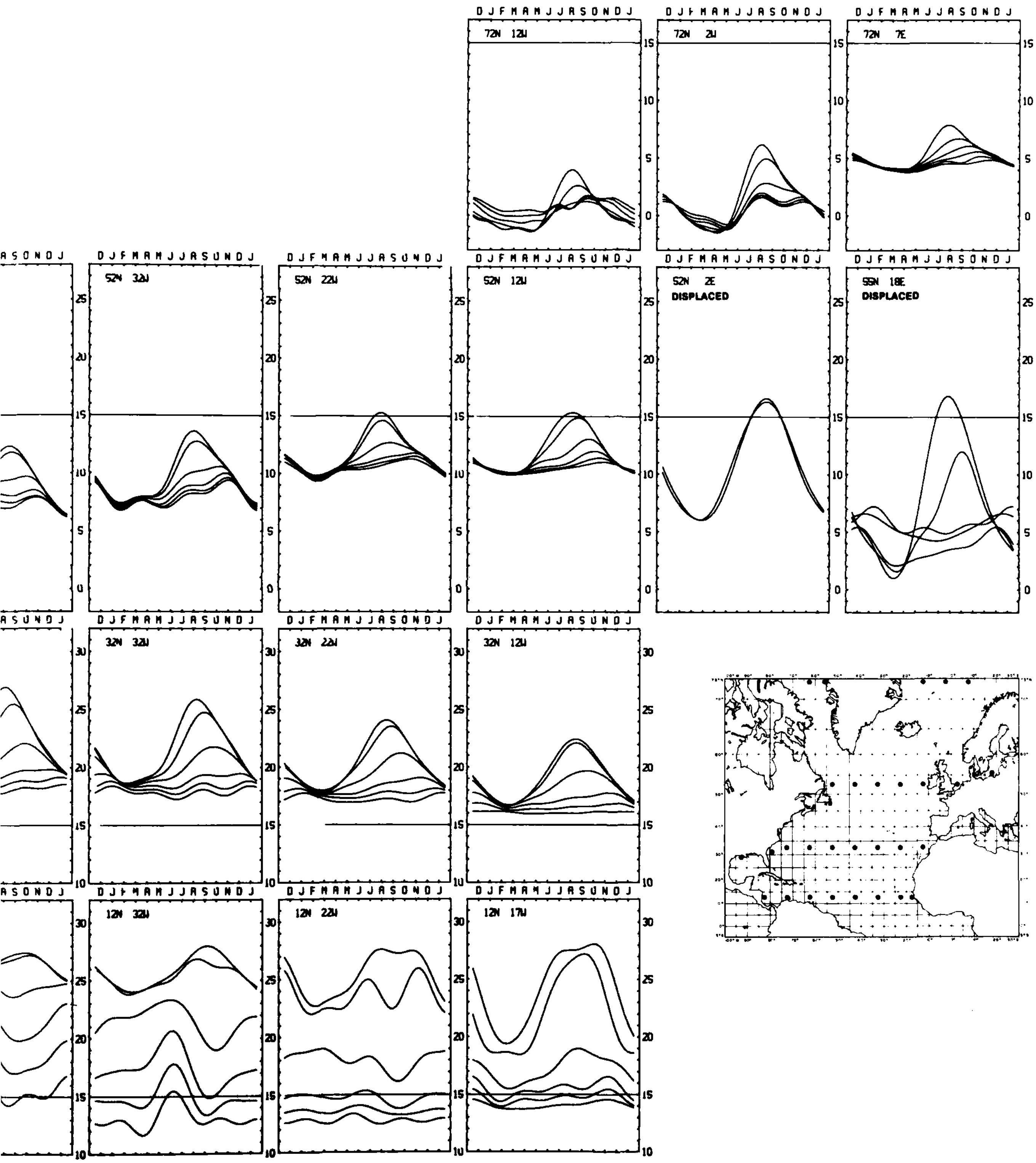


FIGURE 211. ANNUAL CYCLE TEMPERATURE CURVES — ATLANTIC OCEAN 1



RATURE CURVES — ATLANTIC OCEAN 12°N, 32°N, 52°N, 72°N

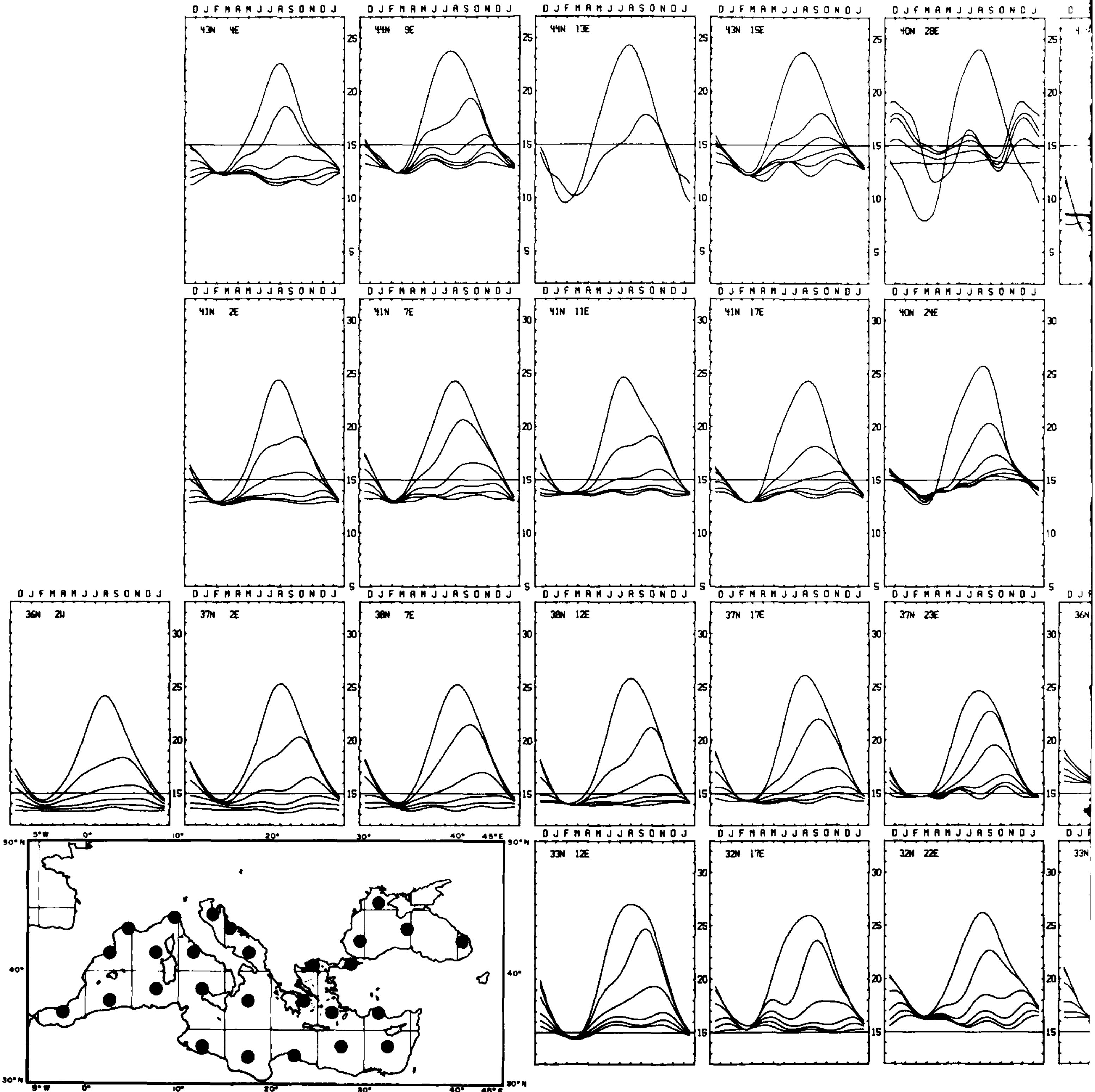
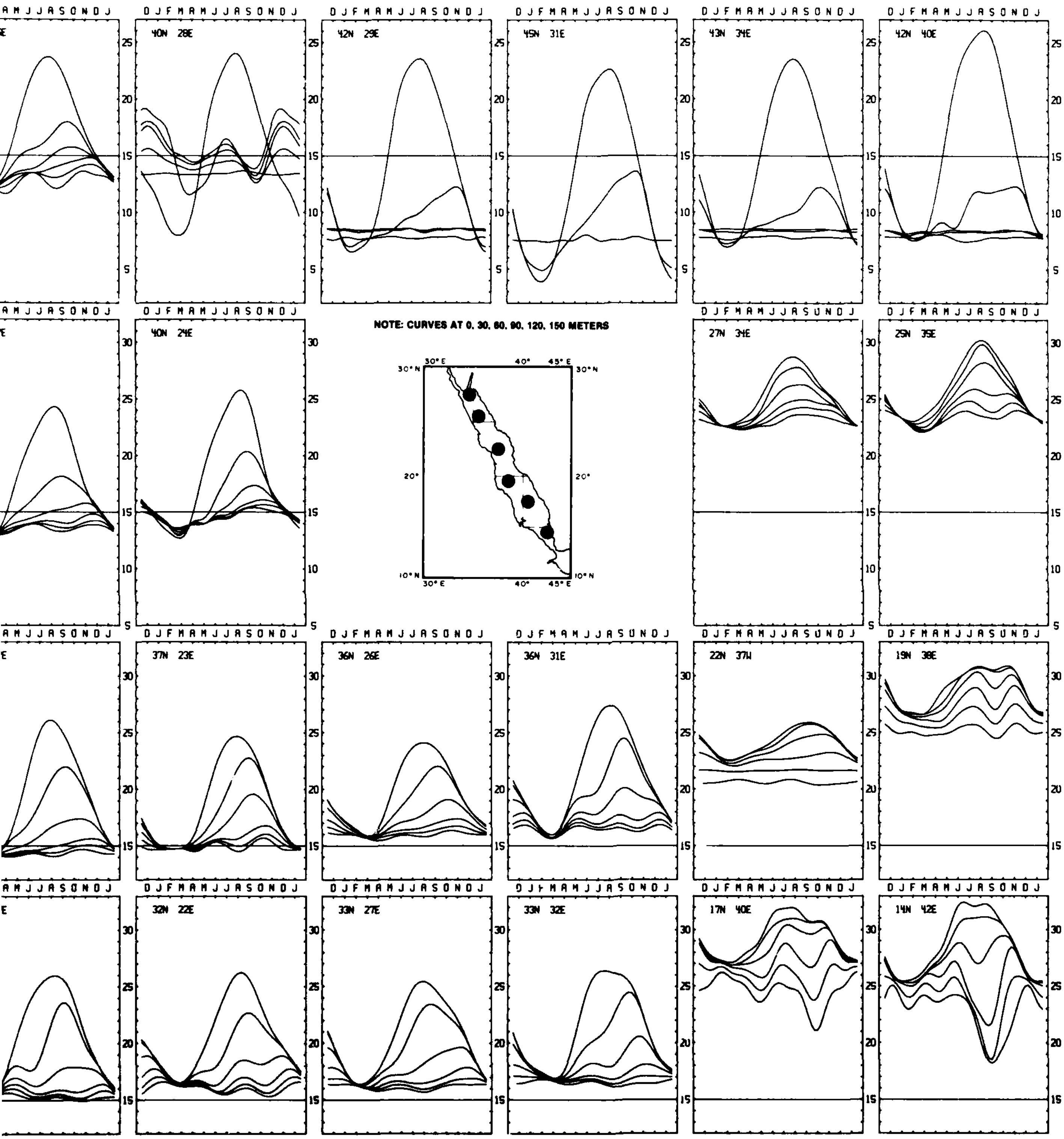


FIGURE 212. ANNUAL CYCLE TEMPERATURE CURVES — MEDITERRANEAN, REI



TEMPERATURE CURVES — MEDITERRANEAN, RED AND BLACK SEAS

2

NOTE: CURVES AT 0, 30, 60, 90, 120, 150 METERS

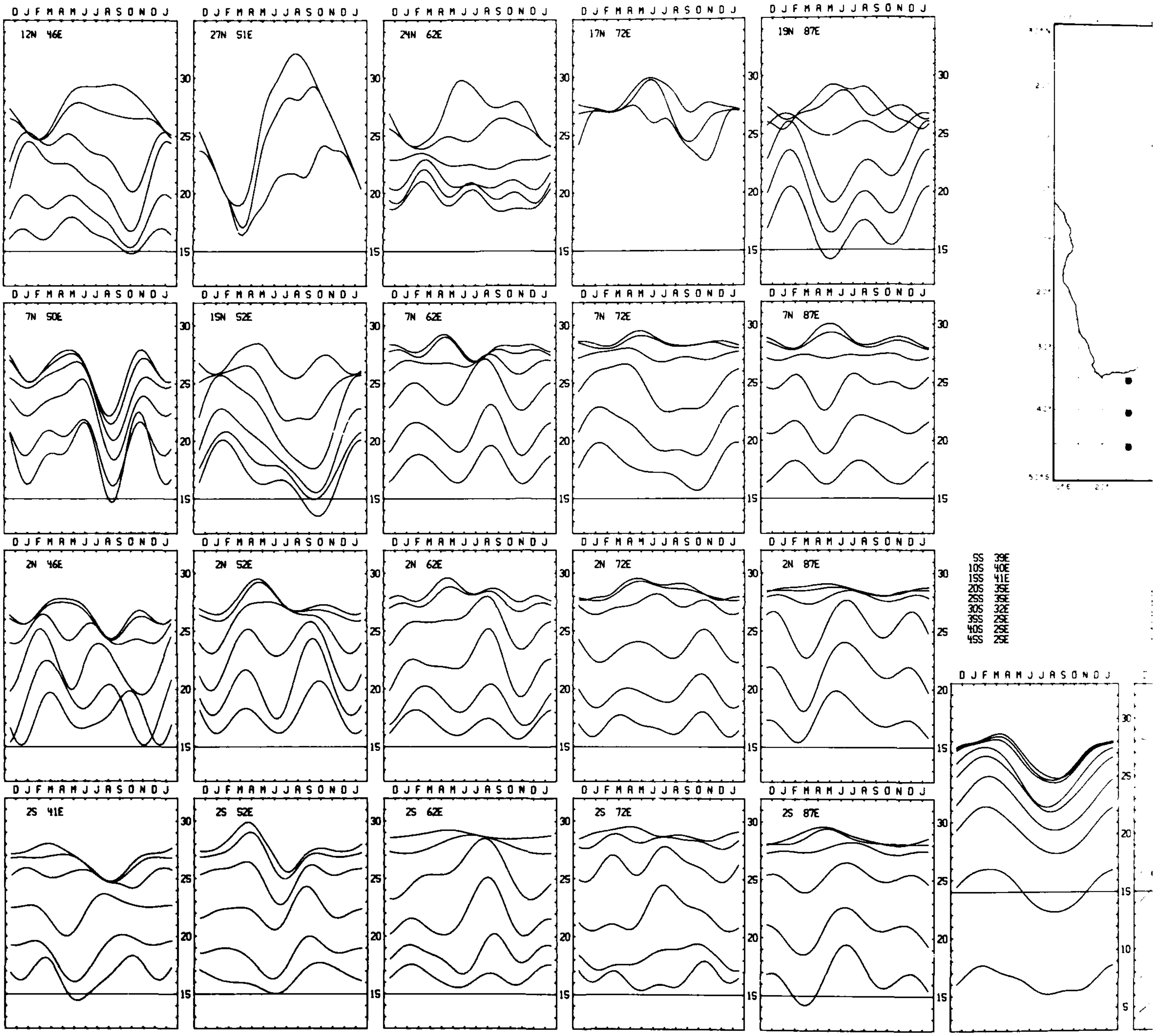
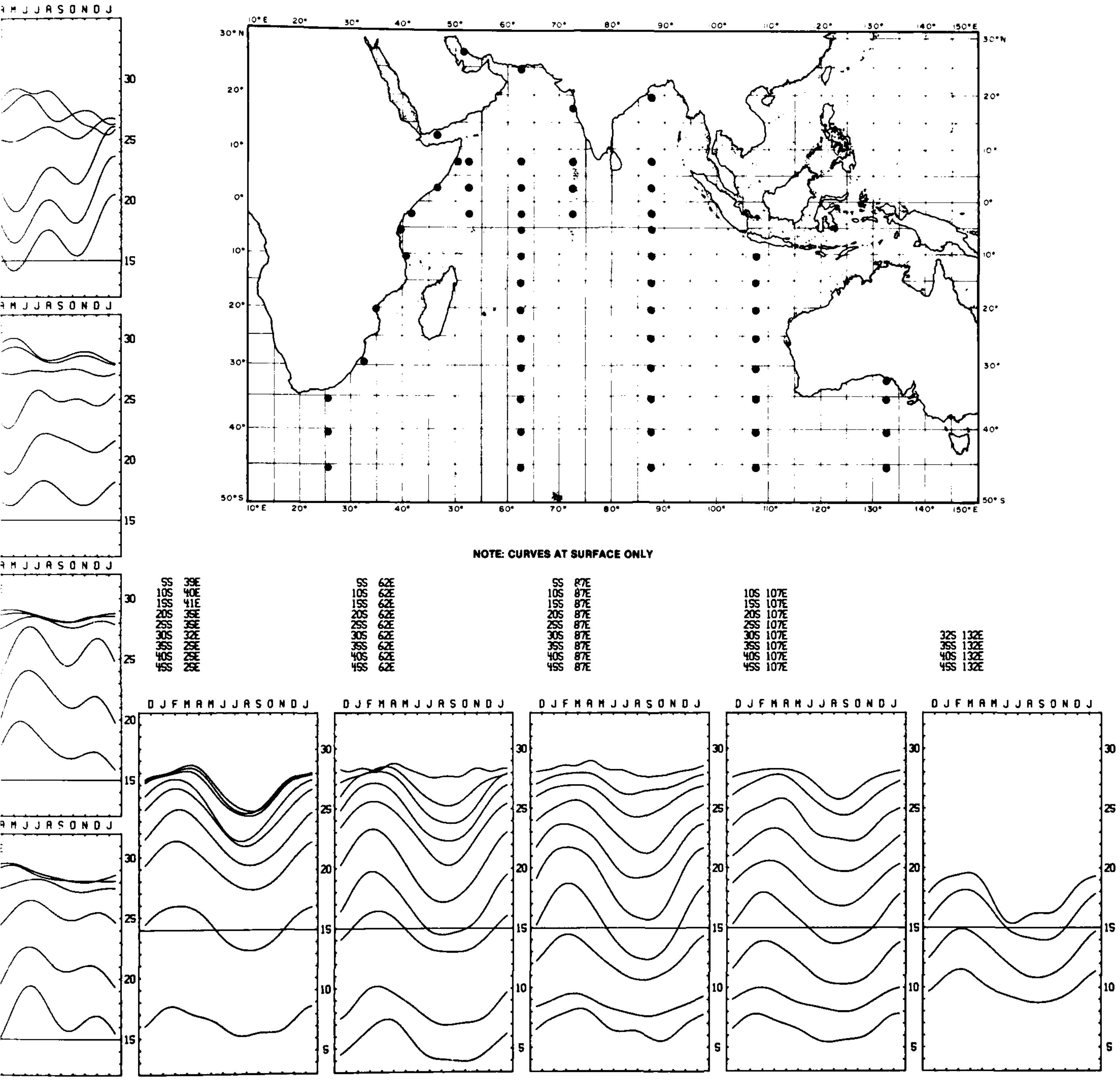


FIGURE 213. ANNUAL CYCLE TEMPERATURE CURVES — INDIAN



UAL CYCLE TEMPERATURE CURVES — INDIAN OCEAN

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE	READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER: NOO RP-18 — 2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle): ATLAS OF NORTH ATLANTIC-INDIAN OCEAN MONTHLY MEAN TEMPERATURES AND MEAN SALINITIES OF THE SURFACE LAYER	5. TYPE OF REPORT & PERIOD COVERED: Reference Publication
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): Margaret K. Robinson, Roger A. Bauer, Elizabeth H. Schroeder	8. CONTRACT OR GRANT NUMBER(s): See Reverse
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Compass Systems, Inc., 4640 Jewell St., #204, San Diego, California 92109 — See Reverse	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS: Naval Oceanographic Office, NSTL Station, Bay St. Louis, MS 39522	12. REPORT DATE: 1979
	13. NUMBER OF PAGES: 234
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)	15. SECURITY CLASS. (of this report): Unclassified
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Temperatures (mean monthly & annual)	Thermocline depths
North Atlantic Ocean	Temperature differences
Indian Ocean	Temperature ranges
Salinities	Annual cycle temperature curves

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Temperature structure in the North Atlantic and Indian Oceans is presented in monthly means charts at 100 ft (30 m) depths, surface to 492 ft (150 m). These charts were constructed from bathythermograph (BT) data obtained from 1942 to 1970, hydrocast data, means extracted from published charts, and unpublished tabulations of means. The charts were traced from computer-generated plots made directly from 1° quadrangle temperature means.

Annual cycle temperature curves, at 10°-longitude and 5°-latitude intervals,

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE
S/N 0102-014-6601

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

FRONT

SECURITY CLASSIFICATION OF THI

8. ONR Contracts:

NSF Grants:

FNWC Contracts:

NMFS Contracts:

9. Scripps Institu
P. O. Box 109
La Jolla, Calif

Woods Hole Ocea
Woods Hole, Mass

20. ABSTRACT (con.

contrast the remarkab
where the greatest cha
where the annual range
is large. The occurre
seen on these curves.
Tight horizontal te
mass boundaries or, be
level with the thermoc
(1.1°C) less than the
difference between the
strength of the thermo
400 ft.
Salinity charts are
means, rather than tru
Data Center hydrocast
Charts of annual me
for the six depth leve
Data analysis was a
tive time series inter

8. ONR Contracts: #N0014-69-A-0200-6006
#N0014-69-A-0200-6049
#NONR-2196(00)083-004
#N00014-66-C0241 NR083-004

NSF Grants: #G-14794
#G-19240
#GP-3245
#ATM75-22535-000
#ATM75-22535-001

FNWC Contracts: NONR 2216 (23)
N00228-69-C-1821
N00228-69-C-1520
N63134-0156-5171
N66314-71-C-2493
N66314-71-C-2584

NMFS Contracts: 01-5-043-189

9. Scripps Institution of Oceanography
P. O. Box 109
La Jolla, California 92037

Woods Hole Oceanographic Institution
Woods Hole, Massachusetts 02543

20. ABSTRACT (con.)

contrast the remarkable changes in seasonal cycles from the northern latitudes, where the greatest change is at the surface, to the equatorial current region, where the annual range at the surface is very small and the subsurface range is large. The occurrences of middepth temperature maxima or minima also can be seen on these curves.

Tight horizontal temperature gradients are associated with current, water mass boundaries or, beneath the surface, with the intersection of the depth level with the thermocline, defined as the depth where the temperature is 2°F (1.1°C) less than the surface temperature. Charts showing the temperature difference between the surface and 400 ft (120 m) are an estimate of the strength of the thermocline gradient between the top of the thermocline and 400 ft.

Salinity charts are presented for the six depth levels. They are all-data means, rather than true annual means, based on the 1969 National Oceanographic Data Center hydrocast tapes.

Charts of annual mean temperatures and temperature range are also presented for the six depth levels.

Data analysis was a combination of objective computer functions and subjective time series interpolations, and means are available on computer tapes.

END

DATE
FILMED
9-80

DTIC